

Changes in wine perception induced by food: influence of physiological and psychological factors

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Napa Valley

CABERNET SAUVIGNON

“Wine has been with us since the beginning of civilization. It is the temperate, civilized, sacred, romantic, mealtime, beverage recommended in the Bible. Wine has been praised for centuries by statesmen, philosophers, poets & scholars. Wine in moderation is an integral part of our culture, heritage and the gracious way of life.”

Taken from Fuller (1996).

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ABSTRACT

The present work assessed the effect of food on wine preference. Four commercial Greek and Portuguese wines, two reds and two whites, with different sensorial features were used. An additional objective was to evaluate the intensity and liking of acidity, astringency and moderate sweetness in white wine, using as tastants tartaric acid, tannic acid and sucrose. The tastings were performed by a trained panel of 28 individuals, segmented by gender, smoking habits, Vinotype, sensitivity to 6-n-propylthiouracil (PROP), saliva flow rate, sweet liking and wine “neophobia” responses. Secondary segments (such as smell sensitivity and tastant liking) were also created during the training process.

The sensitivity and appreciation of the tastants enabled to separate the tasters in two segments, one with high response to the stimulus and another with low. The variation of individual sensitivities followed a normal distribution for tartaric acid and sucrose, contrarily to tannic acid. Concerning the relation between sensitivity to the tastant and the respective hedonic evaluation, there were no correlations ($|r| < 0.3$), indicating that hedonic appreciation was apparently not influenced by sensitivity to the tested tastants.

Concerning food pairing, there was a tendency to decreasing preference for white wines after food consumption, in comparison to that of reds, which tended to increase after pairing. However, when statistically analyzed, the wine ranking did not evidence significant differences and so, all wines performed equally well on pairing with food. This observation may be explained by the cancellation of the different individual preferences when the overall response of the panel was considered. The outcome from the segments sweet liking, smell sensitivity and “neophobia” showed that wine preference could only be related with “neophobia” and not with any physiological or liking factor.

In summary, hedonic appreciation seems to be more connected to our cultural and psychological background and these features should be taken into account to understand the individual wine choices.

Keywords: wine, wine and food matching, food pairing, segments, neophobia.

RESUMO

O presente trabalho avaliou o efeito da comida sobre a preferência do vinho. Foram utilizados quatro vinhos comerciais, dois tintos e dois brancos, com diferentes características sensoriais. Um objetivo adicional foi avaliar a intensidade e o gosto da acidez, adstringência e doçura moderada no vinho branco, utilizando ácido tartárico, ácido tânico e sacarose. As provas foram realizadas por um painel treinado de 28 indivíduos, segmentado por sexo, hábitos de tabagismo, "Vinotype", sensibilidade ao 6-n-propiltiouracilo (PROP), fluxo de saliva, gosto doce e respostas de "neofobia". Segmentos secundários (como sensibilidade ao cheiro e ao gosto) também foram criados durante o processo de treino.

A sensibilidade e a apreciação dos sabores permitiram separar os provadores em dois segmentos, um com alta resposta ao estímulo e outro com baixo. As maiores variações individuais foram encontradas no ácido tânico, enquanto com ácido tartárico e sacarose houve uma evolução de pontuação mais homogênea. Quanto à relação entre a sensibilidade ao sabor e a respectiva avaliação hedônica, todas as correlações foram fracas, indicando que a valorização hedônica não foi determinada pela sensibilidade aos sabores testados e, se houver, as respostas sensoriais apenas contribuíram marginalmente para as respostas aos gostos.

No que diz respeito à relação com a comida, a preferência pelos vinhos brancos diminuiu após o consumo de alimentos, em comparação com os tintos, que aumentaram após o emparelhamento. No entanto, quando analisados estatisticamente, o ranking dos vinhos não apresentou diferenças significativas. Isso ocorreu porque as diferentes direções de preferências individuais cancelavam a resposta geral do painel. Os resultados do gosto pelo doce, sensibilidade ao cheiro e "neophobia" mostrou que a preferência do vinho só poderia estar relacionada com a "neophobia" e com nenhum outro fator fisiológico.

Em resumo, a apreciação hedônica parece estar mais relacionada com o contexto cultural e psicológico e essas características devem ser levadas em consideração para entender as escolhas individuais do vinho.

Palavras-chave: vinhos, vinhos e comida, ligação com a comida, segmentos, neophobia.

RESUMO ALARGADO

O objetivo do presente trabalho foi avaliar o efeito da comida na preferência vinho, enfatizando as respostas de indivíduos treinados, antes e após o consumo de alimentos. Foram usados quatro vinhos comerciais, internacionais, tintos e brancos, com diferentes características sensoriais. A selecção de vinhos gregos e portugueses visava observar comportamento dos provadores para vinhos com origem diferente. Um objectivo adicional foi avaliar em termos de intensidade e apreciação hedónica as sensações de acidez, adstringência e doçura moderada em vinho branco da variedade Macabeo, usando soluções de ácido tartárico, ácido tânico e sacarose.

As provas foram realizadas por um painel treinado de 28 indivíduos, segmentados por sexo, hábitos tabágicos, teste Vinotype, sensibilidade para o 6-n-Propiltiouracil (PROP), fluxo de saliva, preferência pelo doce e “neophobia”. Foram criados segmentos adicionais durante o processo de prova. Tais categorias foram: grau de sensibilidade ao cheiro e grau de sensibilidade às sensações de boca.

Em relação às sensações de boca dividimos os provadores em dois segmentos, um com alta resposta ao estímulo e outro com baixa. A maior variação de sensibilidade foi observada em relação ao ácido tânico. A respeito do ácido tartárico e da sacarose, notámos uma distribuição de pontuação mais homogénea. Na medida em que a relação entre a sensibilidade para o estímulo e a respectiva avaliação hedónica, foi fraca, as respostas sensoriais apenas devem contribuir ligeiramente para a apreciação do vinho. Este facto levou a procurar novas segmentações, não com base nas respostas de intensidade, mas com base nas repostas de preferência pelos gostos.

Sobre a segmentação do consumidor com base nos resultados do gosto doce, os provadores foram divididos em dois segmentos, de acordo com um valor de corte arbitrário de 205 g/L. Os resultados obtidos levaram a incluir 20 dos provadores no segmento de “dislikers” e 8 em “likers”.

A capacidade de emparelhamento de comida foi avaliada com 4 vinhos comerciais (originários da Grécia e Portugal) vinhos através da criação de ordens de classificação (“rankings”). A preferência para os vinhos brancos diminuiu após o consumo de alimentos, em comparação com a dos tintos, que aumentou após o emparelhamento. Houve uma tendência para classificar em primeiro lugar os vinhos brancos antes de combiná-los com o prato. Após o consumo de comida, os vinhos tintos passaram para os primeiros lugares da classificação. No entanto, quando analisados estatisticamente, os “rankings” dos vinhos não ofereceram diferenças

significativas. Isto foi devido o fato de que as diferentes direcções das preferências individuais foram canceladas quando se considerou a resposta global do painel.

O resultado dos segmentos da sensibilidade de cheiro, gosto doce e "neophobia", mostrou que a preferência vinho só foi relacionada com a "neophobia" e não com qualquer outro fator fisiológico. A maioria dos entrevistados não pareceu disposta a experimentar estilos particulares de vinho, mostrando suas dúvidas e desconfiança entre diferentes formas de produção de vinho, ou até mesmo vinhos de diferentes culturas. Especificamente, 19 de 28 provadores foram classificados como "conservadores", enquanto apenas 9 foram caracterizados como "não-conservadores". Um resultado muito interessante, que poderia possivelmente ser usado para futuros estudos. Os resultados sugerem que os jovens actuais se sentem desconfortáveis em explorar diferentes estilos de vinhos, formas de produção e origens, e preferem os vinhos com que já estão familiarizados.

Em suma, quando se trata de vinho e comida, a apreciação hedónica parece estar mais ligada ao nosso fundo cultural, social e psicológico que molda a nossa maneira de experimentar estilos de vinhos desconhecidos. Estudos futuros de apreciação do vinho devem ser mais dirigidos sobre essas características pessoais, do que às capacidades de perceber e descrever as características sensoriais dos vinhos.

Palavras-chave: vinho, comida, harmonização, prova, "neophobia", segmentação.

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LIST OF ABBREVIATIONS

Carbs – Carbohydrates
FNS – Food Neophobia Scale
Ftest – Friedman's test
gLMS/LMS - Labeled Magnitude Scale
gVAS/VAS – Visual Analogue Scale
HL – High Likers
HSD – Honest Significant Difference
ICC – Intraclass Correlation Coefficient
ISA – Instituto Superior Agronomia
LL – Low Likers
mM – molar concentration
PROP – 6-n-propylthiouracil
PTC – phenylthiocarbamide
RjT – Rejection Threshold
r – correlation coefficient
SD – Sweet Dislikers
SL – Sweet Likers
W1 – Hatiri, Alexakis
W2 – Explicit, Alentejano
W3 – Kariki, Alexakis
W4 – Têmpera, Vinho Regional Lisboa

1. Introduction

1.1 History of Wine

Two thousand years ago, the Roman author, Pliny wrote:

“Even in the most favorable circumstances, the intoxicated never see the sunrise and so shorten their lives. This is the reason for pale faces, hanging jowls, sore eyes and trembling hands that spill the contents of full vessels; this is the reason for the swift retribution consisting of horrendous nightmares and for restless lust and pleasure in excess. The morning after, the breath reeks of the wine-jar and everything is forgotten – the memory is dead. This is why people call ‘enjoying life’; but while other men daily lose their yesterdays, these people also lose their tomorrows (Pliny the Elder, n.d./1991).

The history of wine finds its fundamental roots back to the inception of the world's civilizations. The first archaeological proofs of wine production and consumption is orientated in countries such as China (Hames, 2010), Georgia (Keys, 2003), Iran (Berkowitz, 1996), Greece and Armenia (Tondo, 2017), between 7000 and 4100 B.C. Wine has been strictly bonded and described as a part of religion, since its archetypal basis and this is easily shown in the honoring celebrations of the Greeks, towards their favored and cherished God, Dionysus or else known as Bacchus, who has inspired philosophers, artists as well as the life of everyday people (All about Greek wine, 2010). Coming after, the Romans adopted wine in their regular daily habits, contributing by this way to the evolution of viticulture and oenology, as winemaking evolved into a great business.

Wine has evolved as part of life, culture and diet since time immemorial. One can easily understand and evaluate the worth of wine, by monitoring its several roles among societies, inherited from one generation to another and with the years passing by, wine was considered a significant part of daily diet and people begun to favor stronger, heavier wines. According to Charters (2006), it is perhaps, more than any other existing drink, a product which has a substantial symbolic significance that not only gives pleasure, but has gained crucial roles such as adaptation in the culinary and medical sector.

1.2 Wine and Food Pairing

“If food is the body of good living, wine is its soul” (Clifton Fadiman).

Wine has always had a great, long history of being served as an embellishment to food. There is no doubt that every country which is known to have a “popular” food specialty, usually produces a specific wine which is aimed to accompany it (Johnson-Bell, 2012). Food and wine are tightly connected to each other in a cultural way. People combine these two elements in a daily basis, even using them as a communication tool.

According to Harrington (2008), historical events and happenings, as well as policies led by governments show a crucial influence on wine and food products. The cultural impact on food and wine trends is shown every day through a repeated and constant interplay and development of traditions, fashion and climate, which represent the overall gastronomic identity of a region. Differing cultures have developed different prospectives on the food-and-wine pairing process and its importance (Harrington, 2008). Perfect examples could be considered for instance, the general American attitude following the stereotype of “if it feels good, drink it”, the traditional French system of pairing commands a series of strict rules to follow etc. (Harrington, 2008). Food and wine matching may be approached from several potentials depending on one’s confidence in selecting wines, one’s state of mind at the moment, or even the objective of the gathering where the food and wine will be served (Harrington, 2008).

Wine itself, forms part of a “civilized life” and this is important for several reasons. According to Charters (2006), the first is that one of the major symbolic uses of wine is to communicate messages about the sophistication and culture of an individual or a community. The second is the idea that wine is the alcoholic drink of self-control, at least when compared with beer or other alcoholic beverages, has a long tradition (Charters, 2006), a fact that can be pointed out by the Greeks, who considered consumption of wine to be one thing that bounded them from the drunken barbarians around them (Crane, 2003). Third comes the fact that wine, probably more than any other drink, comes in diverse styles, can be made in distinctive ways and is the reflection of production of many countries and regions (Charters, 2006). Last but not least, wine’s significance as a part of civilized life can be pointed out by two more facts, one being the fact that it is actually a naturally produced drink – which it is, essentially, environmentally friendly and reflects nature in much higher level than it does with process and the other, that it is a form of art and expression as, many times stated, wine can be characterized as beautiful and gentle, because of the “aesthetic satisfaction” gained from it as an aesthetic object (Charters, 2006).

Wine is only appreciated in moderation (Wine in Moderation, 2013) and tasting is the introduction of wine to our senses: sight, smell and taste (Peynaud, 1997). But what exactly do we call “Taste”? For the senses of smell and taste are so closely linked that we always taste what we smell and vice versa, meaning that the two work in conjunction (Johnson-Bell, 2012). Apart from that, our sense of sight also aids our sense of taste and this can be supported by the slightest everyday-life example, when by first observing a piece of food, we are more or less aware of how it tastes (well cooked, burned, salty etc.). According to Johnson-Bell (2012), it is understandable that in the same way that different people have different strengths of eyesight or hearing, so people are also born with contrasting abilities in the areas of taste and smell, which can be quite influenced by our cultural and sensorial past. Many questions can rise from the facts mentioned above: To what extent do we differ in our perception of flavors and aromas, and is this variation in taste along a continuum?

Like the other senses, smell and taste serve as a source of information for our brains. Our sensorial logic then discriminates and identifies those different sensations (Johnson-Bell, 2012). When we taste something, we experience a sensation in specific parts of the mouth, the so-called taste buds, which are dispersed throughout the mouth, and some of them have specific sensors (Johnson-Bell, 2012).

1.2.1 Key elements in Wine and Food Pairing

Taking decisions on how to combine the right wine with the food served is a quite challenging task. The key is to focus on what is most important, whether this is the texture or body of the food and wine, or even the flavors, taking into account also the role of the primary sensory components (sweetness, saltiness, acidity and bitterness). The terminology describing food (e. g. herbal, spicy, fruity, smoky) is much extended as well as the terms we use to describe wine (e.g. dry, oaky, tannic, floral) so with all this possible elements it is difficult to determine the one key driver behind matching choices (Harrington, 2008).

According to Harrington (2008), the elements mentioned above could be separated into three general categories: main taste components, texture elements and flavor elements. This more detailed hierarchy of food and wine sensory elements is shown in the Food and Wine Taste Pyramid in figure 1.1.

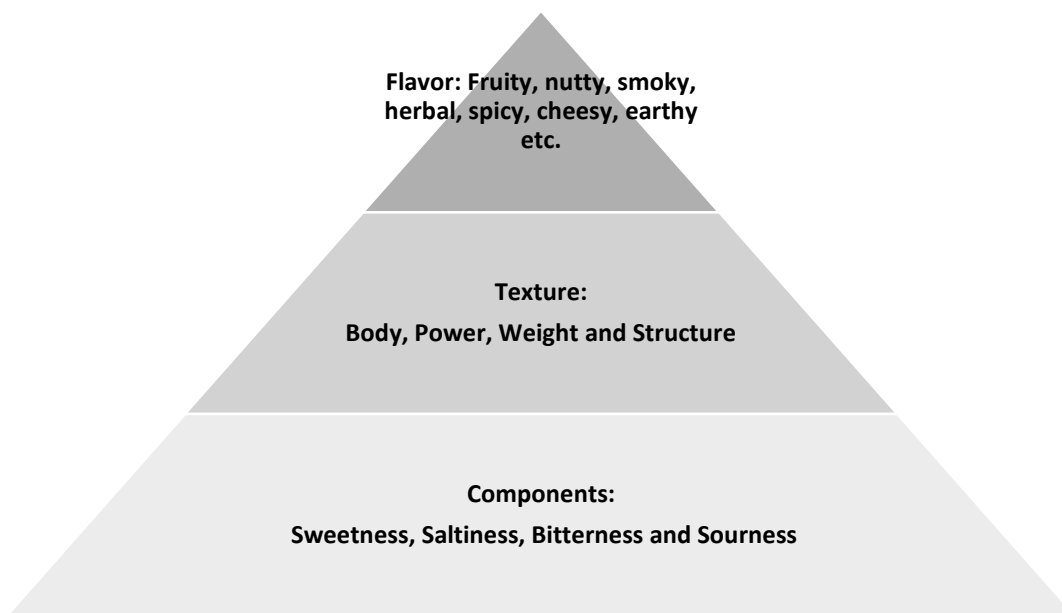


Figure 1.1. The Food and Wine Taste Pyramid (Harrington, 2008)

The view that wine is primarily a food beverage is traditional in many European countries (Jackson, 2009). According to Harrington (2008) there are two main ways to pair wine and food: contrasting or complementary. Complementary flavors have similar characteristics (e.g. two sweet foods such as vanilla ice cream with strawberry sauce – sweet + sweet) whereas contrasting have different characteristics (e.g. pears and Blue cheese – sweet + salty/savory) (International Dairy Deli Bakery Association, 2013). In terms of food and wine pairing, a contrasting match would be a crisp acidity of a dry Sauvignon Blanc with a grilled fat fish. A complementary example is the echo of a raspberry of a young Pinot Noir paired with raspberry reduction sauce (Harrington, 2008). Nevertheless, in the search for that paradigm of synergies, the basic motivation for wine and food combination is often forgotten and by that one means the reduction of the strong influence of wine's alcohol content (Jackson, 2009). The consumption of wine with food slows the uptake of alcohol in the intestinal tract (Jackson, 2009).

A proper pairing helps to highlight the strengths of each food without allowing any flavor to become overwhelming. In other words, in order to achieve a successful pairing, it is essential to match the wine texture to the food texture, with the final objective being a complete and pleasant gastronomical experience. The sommelier Madeline Puckette has presented in detail the typical wine pairings, in table 1.1.

Table 1.1. Traditional food and wine pairings (adapted from Puckette, 2015).

Wine Styles	Varieties	Food pairing
Light Dry Whites	Sauvignon Blanc, Pinot Grigio, Alvarinho	Green Vegetables (raw and cooked), Fish
Rich Whites	Chardonnay, Oaked Whites, Viognier	Roasted Vegetables, Fish, White Meat
Sweet Whites	Riesling, Chenin Blanc, Moscato	Soft Cheese, Carbs ¹ , Cured & Smoked Meat, Dessert
Sparkling Wines	Champagne, Prosecco, Cava, Franciacorta	Green Vegetables (raw and cooked), Cheese, Carbs ¹ , Fish
Light Reds	Pinot Noir, Grenache, Pinotage, Gamay	Roasted Vegetables, Rich Fish, White Meat
Medium Reds	Sangiovese, Merlot, Cab. Frank, Tempranillo	Hard Cheese, Carbs ¹ , White, Red & Smoked Meat
Strong Reds	Cab. Sauvignon, Syrah, Zinfandel	Hard Cheese, Red & Smoked Meat
Dessert Wines	Port & Tawny Port, Sherry, Late Harvest Tokaji	Soft Cheese, Carbs ¹ , Smoked Meat, Dessert

¹Carbohydrates.

After taking a look at the table 1.1, it is worth it pointing out some interesting highlights. For instance, the urban myth that dark chocolate fits perfectly with red wine is being doubted here, and the justification for that is the fact that the bitter flavors in chocolate multiply with bitter tannins in the wine, something that makes the entire pairing taste even more bitter (Puckette, 2015). Furthermore, one can say that sparkling wine pairs with a wide variety of foods as it acts like a palate cleanser (Puckette, 2015). Table 1.2 briefly presents past studies that have been established and could be characterized as comparable to our work. Each of the studies, follow approximately the same principles, aiming to match specific food items with certain wine varieties.

Table 1.2. Past studies that focused on food and wine pairing aspects

Study Details	Consumer group	Attributes		Reference
		Positive match	Negative match	
Cooked foods and wines	8 trained members	Riesling/ grilled pork loin Pinot noir/ grilled pork loin Merlot/grilled pork loin Cabernet Sauvignon/ grilled pork loin	Riesling/ braised beef Pinot noir/chicken & Papillote Merlot/ chicken & Papillote Carbenet Sauvignon/ chicken & papillote	Harrington (2007)
Wine and cheese	13 member trained panel	Pinot noir/ Boursin Riesling/ Grana Padano Pinot noir/ Gruyere Riesling/ Danish Blue	Chardonnay/ Boursin Merlot/Grana Padano Carbenet Sauvignon/ gruyere Chardonnay/ Danish Blue	Harrington (2008)
Chocolate and beverage pairing	16 participants	Chocolate best match/ Port wine	Chocolate/ mineral water	Lambri et al. (2012)
Sauvignon Blanc, Chardonnay, Cabernet Sauvignon and Port wine, cheeses, salami and chocolate	248 participants ranged in expertise levels and in industry	SB/ Chevre CD/ Brie CS/ Salami PT/ chocolate	PT/ Chevre PT/ Brie PT/ Salami CS/ chocolate	Koone et al. (2014)
Sauvignon Blanc and Ruby Port with goat cheese and chocolate	79 Students and senior level	SB/goat cheese and RP/ chocolate significantly	SB/ chocolate and RB/ goat cheese	Harrington & Seo (2015)
Aragonez, Blend of Touriga Nacional, Tinta Roriz and Tinta Barroca, Baga and portuguese farinheira stew (sausage and bacon dish)	20 trained students with agricultural background/ 29 untrained students with agricultural background	Blend of TN, TR and TB/ farinheira stew/ Baga/ farinheira	Arragonez with farinheira stew	Almeida (2017)

1.3 The impact of “Neophobia” in Wine Tasting

After initially attempting to eat almost everything, children usually develop neophobia – a distrust to try new foods (Jackson, 2009). The inactivation of neophobia, not only in terms of trying new kinds of food, but also any kind of beverages, juices etc., can take decades. In a more general approach, there is a coexistence between a

demand for modernity and naturalness regarding diet and food, including the need for novelty (neophilia) as well as caution, concerning new, unknown food (neophobia) (Coppola et al., 2014) as well as, in our case, particular styles of wine. It is known that there exists a population of individuals who are hesitant to try new wines and by new it is meant the sum of particular styles such as Orange or Biodynamic wine, wines originating from other countries or even continents, wines with different, innovative and sometimes unfamiliar with the tasters ways of production etc.

It's understandable that cultural variables may play an important role in influencing responses to new styles or foreign wines. The educational background, age, gender and many other social-demographic factors could have an impact on how willing the people are to taste new wines. This wine “neophobia” should be overcome through repeated development of knowledge, informing and promoting a global and friendly tasting environment.

1.4 Taster Segmentation

The term “segmentation” includes all the procedures that aim to divide people into groups by using specific categories, such as gender, age, origin or in our case, tasting experience. Special attention should be given when it comes to create consumer/taster segments, as through this procedure we receive information about taste sensitivity and preferences as well (Almeida, 2017). The most common distinctions are based on different categories linked with demographic, physiological, psychological and taste sensitivities. The segmentation can be achieved usually by simple demographic questionnaires (e.g. with questions aiming to know the gender, age, origin, educational and cultural background etc.) as well as by tests and measurements of the taste functions. When it comes to taste function measurements, parameters such as saliva flow rate, sensitivity to 6-n-propylthiouracil (PROP), sweet liking rates etc. should be evaluated and taken into account. Apart from the tests mentioned above, there is a quick online test, the so called “Vinotype”, which is based on questions concerning feelings and intuition, and has been proved to assume personal wine preferences (Hanni, 2013).

1.4.1 Saliva Flow Rate

Saliva is the first physiological discharge induced by ingestion of foods or beverages and its reaction is considered essential in the oral cavity as well as in taste perception (Stokes, 2013). It can affect significantly the perception of taste through titration, dilution and precipitation of stimuli (Ceciliani, 2017). As it is expected, individuals vary a lot in their salivary flow rates, but what is rather interesting is that there are significant differences in the concentrations of the salivary constituents in the same individual, under different circumstances (Matsuo, 2000). The saliva flow rate can be determined with the stimulation of citric acid (Ishikawa and Noble, 1995). The principles of this method implement that the taster ingests 10 mL of citric acid (with a 4 g/L concentration) and after 10 seconds gathers the expectorated saliva into a cup. The procedure is complete when the saliva produced in one minute is being weighted (Smith et al., 1996), dividing the tasters into low or high producers, using as a cut-off the average saliva weight obtained by the sum of the participants.

1.4.2 Taster Phenotype – PROP

According to Tepper (2001), the ability to taste the bitter thiourea compound phenylthiocarbamide (PTC) as well as 6-n-propylthiouracil (PROP) is an inherited characteristic shared by approximately 70% of the US adult Caucasian population, the so called PROP medium tasters and supertasters. The remaining 30% of the population receive PROP as weak or tasteless and they are called nontasters (Tepper et al., 2001). Thioureas contain the chemical moiety N-C=S , which is responsible for its bitter taste (Bartoshuk et al., 1994). It is shown through past studies that PROP tasters (medium tasters and supertasters) generally perceive greater intensity than the nontasters, from a wide variety of compounds, such as caffeine, quinine, benzyl alcohol and many others (Tepper et al., 2001). Prop tasters are also known to show greater sensitivity to oral irritation from capsaicin, cinnamaldehyde and benzyl alcohol (Prescott et al., 2000). The ability to taste this compound is more common in women than in men (Whissell-Buechy and Wills 1989); therefore, women are supertasters more frequently and have more fungiform papillae and more taste buds (Bartoshuk et al. 1994). Also, according to Whissell-Buechy (1990) this ability is present in young children, declining slowly with age.

The PROP sensitivity evaluation procedure includes a tasting with 3 glasses with 20 ml of water solutions displayed in increasing order of concentration of the compound (6-n-propylthiouracil), 0.032 mM, 0.32 mM and 3.2 mM. The procedure is

simple, requesting from the taster to evaluate in terms of intensity perceived, the bitter sensation of each concentration in a 100 mm general Labeled Magnitude Scale (gLMS) and are following classified through the score given to the 0.32 mM solution (Non-taster ≤ 15.5 mm; $15.5 < \text{Taster} < 51$ mm; Super-taster ≥ 51 mm) (Pickering et al., 2004).

1.4.3 Vinotype

The vinotype test is an online wine personalization test (www.vinotype.com) which is principally based on the preferences of the individuals, launched in 2011 (Hanni, 2013). The developer of the vinotype test was Tim Hanni, an American Master of Wine, whose objective was to help consumers find out more about their own preferences. Hanni (2013) takes a phenotypic approach, which demonstrates that all organisms can be categorized into phenotypes, that in the case of individuals, the phenotype is the composite of the individual's observed properties, characteristics and traits (Borchgrevink and Sherwin, 2017). In sum, the phenotypic approach suggests that individuals develop (behavioral, food, entertainment) preferences over time based on their experiences and interaction with their broader environment (Borchgrevink and Sherwin, 2017). Adapting the phenotypic approach to the world of wine and wine preference, Hanni (2013) proposes the use of vinotype, defined as "The set of observable characteristics of a wine-imbibing individual resulting from the interaction of its genotypic sensory sensitivities in a wine-related environment".

The philosophy of the test is that the subjects will answer to several questions, which in the end will determine, according to their personal statements and preferences, their sensory sensitivities and tolerances, thus their characterization. The four primary categories of vinotype are the following: Sweet, Hypersensitive, Sensitive and Tolerant.

Table 1.3. Categories of Vinotype personalization test (adapted from Hanni, 2013 and Borchgrevink and Sherwin, 2017).

Vinotype	Description
Sweet	<p>Greater preference to sweet foods and/or fragrant sweet wines with low alcohol</p> <p>Preferred wines: Chardonnay, Moscato, Pinot Noir, Riesling, Sangria, Sparkilings</p> <p>Higher number of tasting buds</p> <p>More likely to be women (approximately 21%) and 7% men</p>
Hypersensitive	<p>Greater preference to lower alcoholic content wines, delicate dry or off-dry, aromatic and smooth wines</p> <p>Preferred wines: Blush/Rose, Chardonnay, Gamay, Pinot Grigio, Pinot Noir, Riesling, Sparklings</p> <p>Intense sensory experiences</p> <p>About 38% of women and 36% of men</p>
Sensitive	<p>Widest range of wine preferences, willing to try new flavors and styles</p> <p>Preferred wines: All styles</p> <p>Tendency for delicate or full-bodied wines, dry whites and rich reds</p> <p>About 25% men and women</p>
Tolerant	<p>Preference for more tannic, powerful, full-bodied reds, intensity and high flavor in whites</p> <p>Preferred wines: Cab. Sauvignon, Malbec, Pinot Noir, Sauvignon Blanc, Syrah</p> <p>Willing to try wines with higher alcohol</p> <p>Approximately 16% of women and 32% of men</p>

1.4.4 Sweet Liking

Despite the fact that sweetness is generally a desirable taste, consumers can be divided into two groups, sweet likers and dislikers, according to their hedonic responses and preferences to sucrose solutions (Methven et al., 2016). As humans have an innate tendency for liking sweet flavors, the term “sweet dislikers” is somewhat inaccurate. SD according to Methven et al. (2016), are unlikely to dislike sweetness in totality, but slightly prefer moderate sweetness levels to high sweetness ones.

One approach to evaluate the differences among the degree of tolerance for sweetness, between SL and SD is to measure the point at which food or beverage (in this case wine) is rejected when a quality (in this case sweetness) is being increased (Methven et al., 2016). Such points are known as "Rejection thresholds" (RjT) and they have been previously determined for tastes and flavors that are claimed to have a strong impact on acceptability (Methven et al., 2016).

The evaluation of sweet liking is commonly demonstrated by simple tests that include liking of sucrose solutions using visual analog scales (VAS), to establish SL and SD classifications. VAS is the most common pain scale, being used worldwide for quantification of several chronic painful diseases (Sinha et al., 2017). VAS can be presented in a number of ways, including: scales with a middle point, graduations or numbers (numerical rating scales), meter-shaped scales (curvilinear analogue scales), "box-scales" consisting of circles equidistant from each other (one of which the subject has to mark), and scales with descriptive terms at intervals along a line (graphic rating scales or Likert scales) (Scott & Huskisson, 1976). In general, VAS scales are considered a reliable instrument for more valid and exact measurements than other types of scales, they are more sensitive to small changes and take less than 1 minute to complete, however, assessment is clearly highly subjective and they cannot be administered verbally or by phone as they are used as a paper and pencil measure.

1.5 Background and objectives of the study

Food and wine habits are strongly affected by a variety of cultural norms and events, including the history of a region, the food systems employed, the traditions, trades, belief and local capabilities (Harrington, 2008). The bond between wine and culinary industry is very tight and is getting developed as the years pass by, adapted into the new technologies and innovative processes of production as well as marketing. Food and wine should be considered as two complementary goods that one works in absolute synergy with the other. The main concept behind pairings is that certain elements (such as texture and flavor) in both food and wine interact with each other, and thus, finding the right combination of these elements will make the entire dining experience more enjoyable and pleasant. While there are many books, magazines and websites with detailed guidelines on how to pair food and wine, as well as studies established in the past, most food and wine experts support the idea that the most essential element of food and wine pairing is understanding the balance between the "weight" of the food and the weight (or body) of the wine.

It's understandable that emphasizing on the wine and food separately is much more practical and flexible, as well as simple and straightforward than putting an effort in studying both together as a combination. Therefore, the aims of our study were to develop an experimental approach of wine tasting, first as an individual separate concept and next, accompanied with food as a pairing match. Our first tests aimed to establish the preference for wines with modified bitterness, sweetness and astringency, following the principle that these sensations are claimed to be the basis of food pairing. After, we proceeded to the evaluation of the panel's preferences for 4 commercial national and international wines, originating in Greece and Portugal, when paired with a typical cold Greek dish, in a try to additionally observe the respondents' behaviour towards foreign, unfamiliar wine varieties and food flavors, following past relative studies emphasizing on food and wine "neophobia" (Ristic et al., 2015). As there are few published studies regarding evaluation of tastings with wine and food pairings, different types of tasting were applied to decide which would be the most efficient and accurate ones.

In summary, the objectives of our study were the following:

1. To evaluate the intensity and appreciation of acidity, astringency and sweetness in white wine.
2. To observe and evaluate the behavior of the trained panel towards wine and food matching.
3. To determine which of the 4 commercial wines was more preferred as an accompaniment to a typical Greek (Cretan) cold dish.
4. To observe the tasters' behavior (conservative or not) towards foreign wines, made of indigenous Greek varieties.

2. Material and Methods

2.1 Participant selection

The tasting panel was constituted by 28 students (11 males and 17 females), age 21 to 40 years old (average 24 years, standard deviation 4.6) from the first and second year of the Enology and Viticulture Master (year 2016/2017), as well as by other students from the faculty of Instituto Superior de Agronomia, mainly with agricultural and food engineering backgrounds. All these students were subjected to intensive training in order to get familiarized with the tasting procedure, as well as to get divided into categories determined by physiological or demographic characteristics.

All participants were asked to fill in self-reported questionnaires regarding their education background, demographic information, wine consumption frequency gender, age, smoking habits and vinotype (Appendix I). All sessions took place in the laboratory of Microbiology of ISA and lasted approximately four months, applying from one to three different tests each week, depending on time flexibility and materials.

2.2 Training of the panel

Training began by the evaluation of prototypical tastes (sweet, acid, salt, bitter) and astringency. Several tests were done to select the tasters. The objective of these tests was to determine if the tasters were able to detect the simple tastes. In addition, adaptation to scale utilization (section 2.3.2) was performed by rating several sensations experienced at least once in their life, concerning pain, tastes, and senses (Annex IV).

2.3. Taster characterization

Tasters were characterized in relation to several preferences and physiological functions, using self-reported questionnaires and/or tasting evaluations.

2.3.1 Vinotype

Vinotype is an online test (www.myvinotype.com) based on the individual's wine preferences (Hanni, 2012). It assesses individual taste sensitivities and tolerances and helps the consumers to learn more about their own preferences. The vinotype is the sum of physiological and psychological factors that determine wine preferences and values. The procedure is quite simple, containing short questions that

will give the final characterization of the applicant. The possible four results are: Sweet, Hypersensitive, Sensitive and Tolerant.

2.3.2 Determination of the taste phenotype

The taste phenotype was determined by the taste intensity of 6-Propyl-2-thiouracyl (PROP) (Sigma, St. Louis, USA) using the Labeled Magnitude Scale (LMS). The LMS is a quasi-logarithmic scale with label descriptors that is equivalent to magnitude estimation (Green et al., 1996, Tepper et al., 2001). The LMS has two anchors, one lower with the phrase “barely detectable” and one higher with the phrase “strongest imaginable”. This “strongest imaginable” is related to the taste or oral stimulus ever experienced in everyday life (Tepper et al., 2001). In between there are indications such as “very strong”, “strong”, “moderate” and “weak” that guide the tasters to choose the one that fits more to their preference. According to Green et al. (1996), instructions were given written and orally to the group of the tasters, in order to get familiarized with the LMS: “After you taste the first sample rate the intensity of the sensation by drawing a mark on the LMS Scale. You can use any part of the line scale that seems appropriate for judging intensity.” In general, the participants did not seem to have any confusion in terms of scale utilization, as the instructions were clear and simple to understand. We made sure they would understand that the indication “strongest imaginable” refers to the most intense sensation they have ever experienced including putting food or non-food items in their mouth (Tepper et al., 2001). To have an idea on how they appreciate their “strongest imaginable” sensation, we asked them to evaluate five different sensations by drawing a horizontal line across the LMS scale and after to write down the own “strongest” sensation in any modality sensation they could ever imagine experiencing (Appendix IV – Sheet IV.1). This helped us understand if the tasters understood the nature of the logarithmic scale by were giving reasonable answers.

The concentrations of PROP solutions were of 0.032 mM, 0.32 mM and 3.2 mM, displayed in increasing order of concentration. Approximately two hours before serving, the solutions were brought to room temperature (18 ± 2 °C). The solutions were served in transparent ISO tasting glasses from Schott Zwiesel (Zwiesel, Germany). Prior to each sample, the tasters were asked to rinse thoroughly with water. Each concentration contained 20 ml of solution and the participants were instructed to move the sample from side to side in the mouth for 5-10 seconds and then expectorate. After waiting for 10-15 seconds, they marked in the gLMS scale the intensity of the bitterness taste of each sample. We asked the participants to drink spring water between every sample they tasted and to spit out the sample. Tasters were classified

as Non-Tasters, Tasters or Super-Tasters, according to the response to the bitter stimulus.

2.3.3 Saliva flow determination

The participants were asked to taste a sample of 0.2 mM citric acid, hold it for 10-15 seconds then spit it out and wait for another 10 seconds for the saliva sample to be gathered in a plastic cup. By weighing the samples given, we were able to determine the saliva flow following the procedure described by Smith et al. (1996). The average saliva weight will be used as a cut-off, to divide the panel according to their saliva production, high producers if total amount of saliva produced was higher than it and low producers if the saliva flow was less than the amount referred above.

2.3.4 Determination of sweet liking status

The establishment of sweet liking status followed the studies of Methven et al. (2016) and Asao et al. (2015). Using the VAS liking scale (described in 1.4.4), we requested from the participants to appreciate a solution of distilled water containing 205 g/L of sucrose (quantity based on the Intraclass Correlation Coefficient or ICC's, which is an inferential statistic that can be used in the case of quantitative measurements are made on units that are organized in groups). In our case, ICC implements that adults can reliably rate their liking of sucrose at concentrations ≈ 0.6 M or above) (Asao et al., 2015). Tasters kept the samples in the mouth, waited for the sensation to peak (1-15 seconds) and after spitting, drew a mark on the VAS liking scale (left end "dislike extremely" to right end "like extremely") according to their personal preference. Our goal was to obtain distinction between sweet likers and sweet dislikers using the cut-off value of 7.5 cm (as the VAS scale is 15 cm long, and we used the mid-point to divide the answers of the tasters).

2.3.5 Smell Sensitivity

Smell sensitivity was determined by smelling a control wine from ISA (section 2.4.1). The wine was flavored with increasing concentrations of one aroma solution. Aroma compounds and their concentrations were chosen based on previous research of Gewurztraminer wines (Guth, 1997; Ong & Acree, 1999). The aroma solution was composed by ethyl butanoate, 2-methylpropan-1-ol, isoamyl acetate, 3-methyl-butan-1-ol, ethyl hexanoate, 2-phenyl ethanol, cis-rose-oxide, acetaldehyde, linalool, ethyl octanoate and beta damascenone. Model wine was freshly prepared on the day of the testing. Four wine solutions were prepared with increasing order of concentration of the aroma solution, one witness solution with no aroma solution added, and the other

three with 0,5 ml/L, 1 ml/L and 2 ml/L respectively. Tasters were asked to measure, with a ruler, the distance (in cm) from the glass top to the nose when the smell was noticed. Two classes were obtained, one of high sensitivity and the other of low sensitivity.

2.3.6 Neophobia evaluation

Taking advantage of the fact that two of the four wines used for the food pairing sessions were of Greek origin, after ranking the wines before and after food pairing, tasters filled a separate questionnaire with five simple questions aiming to know how reluctant they seem to be towards different styles of wines (e.g. orange wines), as well as how willing they are to try wines from different countries. The procedure requested from the subjects to choose between two answers (YES/NO) in each of the five questions, adapting the Food Neophobia Scale (FNS) (Pliner & Hobden, 1992), which was developed to assess the topic of innovation and acceptance of multicultural cuisines. The two additional categories were conservative and non-conservative wine tasters.

2.3.7 Taste intensity determinations

Aqueous solutions of tartaric acid, tannic acid and sucrose, served on increasing concentrations each time (Table 2.1). Similarly to the previous sessions, two hours before serving, the solutions were brought to room temperature (18 ± 2 °C). The participants were asked to evaluate the taste intensity of the solutions by using the LMS scale.

Table 2.1. Reagents and concentrations of aqueous solutions used in taste intensity determinations.

Sensations/Tastes	Concentration and Reagent
Acidity	0.1, 1 and 10 g/L Tartaric Acid
Astringency	0.1, 1 and 2.5 g/L Tannic Acid
Sweetness	1, 2, 4 g/L Sucrose

2.4 Taste intensity and liking of aqueous solutions and white wine spiked with several tastants

2.4.1 Wine analysis

The base wine was obtained from the variety Macabeo obtained by classical white wine vinification in ISA winery during the vintage of 2016 (un-oaked). Macabeo is a Spanish variety and has been chosen for its neutral character. Wine was de-acidified using 1 g/L calcium carbonate to reduce fixed acidity (Table 2.2). The wine was spiked with the tastants and the solutions stored at 3-5 °C (in the refrigerator) for three days before tasting.

Table 2.2. Analysis of ISA Macabeo 2016 wine.

	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)	pH	Total acidity (g/L tartaric acid)	Volatile acidity (g/L acetic acid)	Alcohol Strength (%v/v)	Reducing sugars (g/L)
Control	39	105	3.08	6.2	0.23	11.3	0.7
Control after deacidification	-	-	3.52	5.3	-	-	-

2.4.2 Intensity evaluation

The tasting took place in three parts: initially, the subjects were served with five glasses with solutions of tartaric acid, then sucrose and finally tannic acid soaked in distilled drinking water, one glass with control wine and one with water. Following, they were asked to evaluate the samples in terms of intensity using the VAS. As mentioned previously, VAS is the most common pain scale, being used worldwide for quantification of several chronic painful diseases (Sinha et al., 2017). It can be used either for intensity ratings or hedonic appreciation. The increasing concentrations used were 0.15, 0.3, 0.6, 1.2 and 2.4 g/L for tartaric acid, 1.5, 3, 6, 12 and 24 g/L for sucrose and 0.09, 0.18, 0.38, 0.75 and 1.5 g/L for tannic acid, respectively. After completing each tasting, we asked the participants to write down which sensation they perceive from the content of the glasses, in order to determine if they are capable of identifying the increase of the concentrations and thus select the optimal candidates to complete the panel.

An additional tasting was organized later, following the principles of the previous mentioned above, this time using white wine as a solution instead of distilled drinking water. Approximately two hours before serving, the solutions were brought to room temperature (18 ± 2 °C). Labeled 20 mL samples of tartaric acid (in concentrations of 0.15, 1.3, 0.6, 1.2, 2.4 g/L), sucrose (in concentrations of 1.5, 3, 6, 12 and 24 g/L) as well as tannic acid (concentrated in solutions of 0.093, 0.1875, 0.375, 0.75 and 1.5 g/L) were served to the participants together with a glass of the control

wine and one of water. Initially, the participants were asked to rinse their mouth with filtered water before starting the samples tasting. After, the subjects were asked to put the samples in their mouth and rinse for 10 seconds, being sure that they cover all the mouth surfaces and wait for the sensation intensity to peak (10-15 seconds). Following, they were requested to draw a mark on the intensity scale as well as in the liking scale (see below) according to their personal preference. The estimated break-point between the several samples, was approximately one minute.

All the samples were presented blind, randomized and coded with three random digit numbers. During the tasting, two additional glasses were used, one served with the control wine, and one with spring water. Control wine was not scored in the results. This warm-up sample helped the tasters to have an overall idea of how the wine genuinely tastes, without any additions. All results are presented in Annexes 3.1 to 3.3.

After collecting and observing the data from increasing concentrations of tartaric acid, tannic acid and sucrose soaked in wine, we found that it was necessary to apply a repetition of sucrose tasting, as the majority of the tasters were not able to detect the sweet sensation. Therefore, we established a new tasting, this time using double concentrations of sucrose (reaching 6, 12, 24, 48 and 96 g/L respectively), spiked in wine and following exactly the same principles as in the previous one. Participants were blinded to the concentration of sucrose they were tasting and the solutions were presented in random order. This additional session was established mainly for training reasons, in order for the panel to practice their skills in terms of detecting and recognizing better any increase occurring on the concentrations, as well as to offer them one more chance to train themselves before the final wine tasting and food pairing session. The results kept were the ones obtained by the first formal tasting and not this one. The results from the increased concentrations of sucrose are presented in Annex 3.1.2.

2.4.3 Hedonic evaluation

The participants were familiarized with the hedonic visual analogue scale (VAS) in order to facilitate correct scale use. The hedonic VAS scale (15 cm, scaled 0-100), was marked with a neutral point at half scale length and had end-anchors from “dislike extremely” to “like extremely”, always following the instructions given by Methven et al. (2016). The VAS score was determined by measuring in centimeters from the left hand end of the line to the point that the respondent marks using a ruler (Gould et al., 2001).

The tastants tartaric acid, tannic acid and sucrose were served on increasing concentrations each time. Similarly to the previous sessions, two hours before serving, the solutions were brought to room temperature (18 ± 2 °C). The tasting took place in three parts: initially, the subjects were served with five glasses with solutions of tartaric acid, then sucrose and finally tannic acid soaked in wine, always accompanied with a glass of water. They were asked to evaluate in terms of intensity and liking the samples given, using the VAS and gVAS scales. The increasing concentrations used were 0.15, 0.3, 0.6, 1.2 and 2.4 g/L for tartaric acid, 1.5, 3, 6, 12 and 24 g/L for sucrose and 0.09, 0.18, 0.38, 0.75 and 1.5 g/L for tannic acid respectively. In the end of each tasting, the participants were requested to write down again which sensation they perceived from the content of the glasses, so as to determine if they are able to recognize the mouthfeel sensation.

2.5 Influence of food on wine preference

2.5.1 Wine characteristics

Four different wines were used for the tastings, originating in two countries, Greece and Portugal, aiming to offer a broad range of sensory and cultural features and styles. The technical characteristics of the wines are briefly presented in table 2.3.

Table 2.3. Brand and technical characteristics of the wines used in food pairing.

Wine	W1	W2	W3	W4
Producer	Alexakis	Jorge Rosa Santos	Alexakis	José Bento dos Santos
Brand	Hatiri	Explicit	Kariki	Têmpera
Country	Greece	Portugal	Greece	Portugal
Type	Dry white	Dry white	Dry Red	Dry Red
Grape Varieties	Malvasia Aromatica	White blend	Kotsifali 60% Mandilari 40%	Tinta Roriz
Vintage	2016	2015	2015	2013
Denomination	Heraklion, region of Crete	Alentejo	Heraklion, region of Crete	Vinho Regional Lisboa
Aromatic Intensity	High	Medium	Medium	Medium
Alcohol	13% (v/v)	13% (v/v)	12.4% (v/v)	14% (v/v)

Wine number 1 was a quite aromatic dry white wine, mono-varietal of the Malvasia Aromatica grape variety, originating from the island of Crete, region of

Heraklion, Greece. Among the four selected wines, “Hatiri” was the most aromatic and intense wine with revealing citrus fruit notes. Smooth and creamy with a balanced taste, and an aromatic aftertaste of jasmine and night flower, a plant of a most distinct aroma, indigenous to Crete (Alexakis SA, 2013). The vines were planted in sandy clay loam soils, rich in calcium, with density of 3.800-4.200 vines per hectare. Cold settling and injection with selected yeast follow, to highlight the aromatic varietal profile. The wine was fermented in stainless steel tanks for 10-12 days at temperatures that did not exceed 16°C. The purpose of its selection was to observe the preference of the tasters when it comes to combining such an aromatic type of wine with food.

Wine number 2, was a medium aromatic dry white wine, made of Portuguese white blend, with denomination of Alentejo, Portugal and more specifically, from an one hectare old (80-100 year old) field blend vineyard in Portalegre located at 540 m above sea level. Explicit is a wine that gives the dominant impression of salty minerals and creamy, nutty lees, carrying a vegetal character as well. It was fermented and aged in oak barrels for 7-8 months. More neutral than the greek white wine used as wine number 1, “Explicit” was chosen to represent the less aromatic intense white wine style.

Wine number 3, “Kariki”, was a dry red wine, blend of the indigenous Aegean red varieties Kotsifali (60%) and Mandilari (40%), which were selected through vineyards in collaboration with vine growers from Heraklion region (island of Crete, Greece). Deep red color, with violet tints, especially when young. It brings a rich and balanced taste and it’s characterized by dense aromas of small red fruits (blackberry, cherry) as well as black pepper notes (Alexakis SA, 2013). Aged six months in tanks that reproduce the barrel’s environment, followed by two months maturation in the bottle. The vinification included the application of micro-oxygenation. “Kariki” was chosen as a representative of mild – easy red wines, in a try to offer to the panel the opportunity to taste two completely different styles of red wine, and observe their preference among food pairing.

Finally, wine number 4, “Têmpera”, made out of Tinta Roriz grapes (100%), is a rich, dry red wine, originating in “Lisboa” region of Portugal. Handpicked grapes, strictly selected. As a wine it is quite aromatic, with notes of ripe fruits, strawberry and raspberry, soft on the palette with slight spicy notes. It is characterized by its medium acidity and tannins and it is aged 14 months in oak barrels, of which 35% are new, having an ageing potential up to 12 years. Fermentation was taking place in stainless steel tanks followed by strict temperature control. A complex wine, to complete the four wines offered to the tasters, in order to obtain the evaluation and appreciation on each one separately, after food consumption.

The complete analysis of the four selected wines is presented in APPENDIX II.

2.5.2 Food recipe

The main objective of this work, as previously mentioned, was principally to analyze the preferences of the tasters when it comes to a complete wine tasting accompanied with food pairing, as well as to observe their reactions towards wines with different origin than that they're used to, by requesting to fill in a self-reported questionnaire referring to "neophobia". Therefore, the chosen dish was a simple cold greek meal, traditionally served in the island of Crete. The dish is called "dakos" (Ντράκος in greek), and it consists of a slice of soaked dried bread or barley rusk, topped with chopped tomatoes and crumbled feta cheese, flavored with herbs such as dried oregano. Olives, salt and pepper can also be added. A quite simple dish to prepare, broadly served in Greece as a starter or a full salad. Each participant was offered an individual dish to taste.

Recipe:

1. Soak the dry bread or barley rusk with a bit of water, so as it will obtain a softer texture.
2. Chop the tomatoes into tiny pieces or even use a grater for more efficiency and spread them on top of the soaked dried bread.
3. Place the crumbled feta cheese above and pour the (preferably extra virgin) olive oil, minding to cover all the surfaces of the dish.
4. Finally, add the herbs (oregano, salt and even pepper) to enrich the flavor.
5. Olive oil was also added as an extra topping.

2.5.3 Wine ranking

The tasting began with the four wines being served in portions of 25 ml, using the ISO standard transparent glasses and the participants were asked to taste each wine and rinse with water between each sample. Following, we requested from them to evaluate each wine sample according to their preference. The second part of the session was dedicated to the food pairing. Specifically, the tasters were asked to try the wine and the food two times, then after the third tasting of the wines evaluate each wine sample, according to its ability in being paired with food. After, they wrote down which was their favorite wine, starting with the most pleasant (1st place) and finishing with the least preferred one (4th place), following the method described in ISO (8587).

Name: _____

Date: _____ Vinotype: _____

Please taste the samples. Rinse with water between each sample. Evaluate each wine sample according to your preference (1st place corresponding to the favorite to 4th the least favorite one)

1st Place: _____

2nd Place: _____

3^d Place: _____

4th Place: _____

Now, taste the wines again, this time combining them with the food served. Taste the wine and the food two times, then after the third tasting of the wines evaluate each wine sample, according to its ability in being paired with food. Which combination is most preferable according to your opinion? Write down your answer starting with the most pleasant combination and finishing with the less preferable as in the above. (1st place corresponding to the favorite to 4th the least favorite one)

1st Place: _____

2nd Place: _____

3^d Place: _____

4th Place: _____

2.6 Statistical analysis

The Analysis of Variance (ANOVA) at $\alpha=0.05$ was used to compare appreciation of the four wines before and after food pairing, globally as well as according to segmentation. The Tukey HSD (Honest Significant Different) test was used to compare all pairwise differences between means, in an attempt to detect any significant differences among pairs of the four wines. All analyses have been performed with the statistical software R-3.2.3 (©2015).

The results of food pairing were evaluated by analysis of ranks following 3 different methods:

a) The Pearson's X^2 (1900) was used to compare the rank changes, which occurred in the trained test panel, with a random change. The numbers corresponding to the ranking given by the trained panel were: first place (1), second place (2), third place (3) and fourth place (4). The test followed the hypothesis that the probability of changing the wine's rank after combining it with the offered dish (ranking order) was random. Hence, in the null hypothesis the probabilities are similar to the ones determined by random selection. As far as the alternative hypothesis is concerned, at least one of the probabilities has been altered. The observed values (O_i) were the direct results from the tasting with the trained panel while the expected (E_i) values were the probability of each change multiplied by the number of tasters.

The formula of the statistical test was the following:

$$X^2_{calc} = \sum_{i=1}^k \frac{(O_i - E_i)^2}{E_i} \sim X^2_{(k-1)\alpha}$$

With k =number of change values that occur.

With a significance level of $\alpha=0.05$ and a critical region unilateral on the right, we will reject the H_0 if X^2_{calc} is greater than $X^2_{(4)0.05} \approx 9.4877$

b) The Friedman's test, in agreement with ISO 8587, was used in order to detect differences in treatments over multiple test attempts. By using the sum of scores of each of the four wines, the test estimates whether or not there are differences among the wines.

The formula of the statistical test was the following:

$$F_{test} = \frac{12}{j \cdot p(p+1)} (R_{w1}^2 + R_{w2}^2 + R_{w3}^2 + R_{w4}^2) - 3j(p+1)$$

Where:

R_w = is the rank sum of wine i

j = the number of tasters

p = the number of wines tasted

If $F_{\text{test}} > 0.781$ (critical values for level of significance $\alpha=0.05$, for 4 samples obtained by 28 tasters) (ISO 8587), considering the number of assessors, the number of samples (products) and the chosen risk, the H_0 is rejected and we conclude that there are differences among the wine preferences.

c) The Spearman correlation coefficient, in agreement with ISO 8587, studies the agreement between two rank orders (ISO 8587) and can be calculated as follows:

$$r_s = 1 - \frac{6 \cdot \sum_i di^2}{p(p^2 - 1)}$$

Where:

p = the number of wines tasted

di = the difference between the rankings before and after food pairing for wine i

There are three possibilities:

If the value of Spearman correlation coefficient approaches +1, there is high agreement between the two rank orders, which means that the ranks were kept. If it is close to 0, the rank orders are characterized as unrelated. If it approaches -1, there is strong disagreement between the rankings, which demonstrates that the rank orders were changed.

3. Results and discussion

3.1 Taster characterisation

The responses reported by the tasters in the questionnaires and in the sensory tests enabled their division in several categories. Table 3.1 summarizes the results of their demographic and physiological characterization.

Table 3.1. Number of tasters in each category.

Category	Class	Number	Percentage
Gender	Males	11	39%
	Females	17	61%
Smoker	Yes	10	36%
	No	14	50%
	Sometimes	4	14%
Vinotype	Hypersensitive	8	29%
	Sensitive	16	57%
	Tolerant	4	14%
Neophobia	Conservative	19	68%
	Non-Conservative	9	32%
Saliva flow	Low Flow	16	57%
	High Flow	12	43%
PROP status	Non-Tasters	10	36%
	Tasters	18	64%
Sweet liking	Sweet Likers	8	29%
	Sweet Dislikers	20	71%
Smell sensitivity	Low	17	61%
	High	11	39%

3.1.1 Questionnaire responses

Most of the subjects were female participants (17 out of 28) whereas the males were 11. Most of the panel was consisted of non-smokers (14), the permanent smokers were 10 and we had also a sum of 4 “social-frequent” smokers who stated that they smoke sometimes. The majority of the tasters were classified as “sensitive” in terms of Vinotype, giving a number of 16, compared to the “hypersensitive” (8) and “tolerant” that were only 4.

Furthermore, quite interesting results were obtained by observing the responses to the self-reported “neophobia” questionnaire, as the majority of tasters were classified as “conservatives” representing a number of 19, compared to the “non-

conservatives” being only 9. The critical question which in fact gave us the clear panel division was the following: “Particular wines (e.g. orange) look weird to me”, having only 9 tasters stating that they would pleasantly try new styles. This conclusion could be used for further future studies, emphasizing on why young people nowadays seem to feel uncomfortable with exploring new pathways of wine tastings, accepting different styles and origins of wine, staying instead strictly attached to what they have already been familiar with. Most of the respondents were classified as wine neophobic (or else conservative), in terms of presenting a slight reluctance, or even sometimes an avoidance to taste particular styles of wine.

Table 3.2 and 3.3 enclose the questions presented in the self-reported “neophobia” questionnaire, together with the classification of the panel’s answers.

Table 3.2. Questions presented in the self-reported questionnaire about “Neophobia” and methodology of the answers.

Questions	YES	NO	Methodology/ Use of the answers	
			YES	NO
1. I’m certainly trying new wines	26	2	1	0
2. I like wines from different countries	27	1	1	0
3. Particular wines (e.g. orange) look weird to taste	19	9	0	1
4. At dinner parties I will try new wines	27	1	1	0
5. I’m afraid of trying wines I’ve never tried before	0	28	0	1

The methodology we followed in order to organize and use the collected data efficiently, was that a self-created “rating system”, which used only two scores, 0 and 1, was applied to each answer to help us categorize them. The idea was that a positive (independent of the word YES or NO) answer would receive 1 point, whereas a negative 0 points. We created two segments, that of conservative tasters and that of non-conservatives, according to the total sum of their individual answers. All the questions except question 3, gave clear and somehow expected results demonstrating that the tasters were willing to try wines from different origin. Regarding question 3, “Particular wines (e.g. orange) look weird to taste”, as described above, surprisingly the majority of the tasters seemed to be unwilling to try something new. Bellow, table 3.3 presents in detail the “scores” given to the question 3 by the respondents and their final classification.

Table 3.3. Analytic scores to Question 3 and taster classification.

Taster	Question 3	Taster Classification
	Scores	
1	1	Conservative
2	0	Non-Conservative
3	1	Conservative
4	1	Conservative
5	1	Conservative
6	0	Non-Conservative
7	1	Conservative
8	0	Non-Conservative
9	0	Non-Conservative
10	1	Conservative
11	1	Conservative
12	1	Conservative
13	1	Conservative
14	1	Conservative
15	1	Conservative
16	0	Non-Conservative
17	0	Non-Conservative
18	1	Conservative
19	1	Conservative
20	0	Non-Conservative
21	1	Conservative
22	1	Conservative
23	1	Conservative
24	1	Conservative
25	0	Non-Conservative
26	0	Non-Conservative
27	1	Conservative
28	1	Conservative

Regarding the rest divisions obtained by the demographic questionnaire, the age, study background, origin and food allergies were not used as categories because of the common features of the tasters, mostly Portuguese students of the master in Viticulture and Enology of ISA and the non-existing sensitivities to allergies or specific dietary preferences.

3.1.2 Sensory responses

The intensity ratings given to PROP status by the trained panel are presented in Figure 3.1, initial segments and in Figure 3.2, after the final panel division. The subjects were classified into three categories, regarding their different taste phenotypes: Non-Tasters, Tasters and Supertasters. In our case, there was only one supertaster (female) left (as the other one was eliminated after the first sessions due to repeated absences). Therefore we had to include her in the segment of Tasters for more appropriate data treatment.

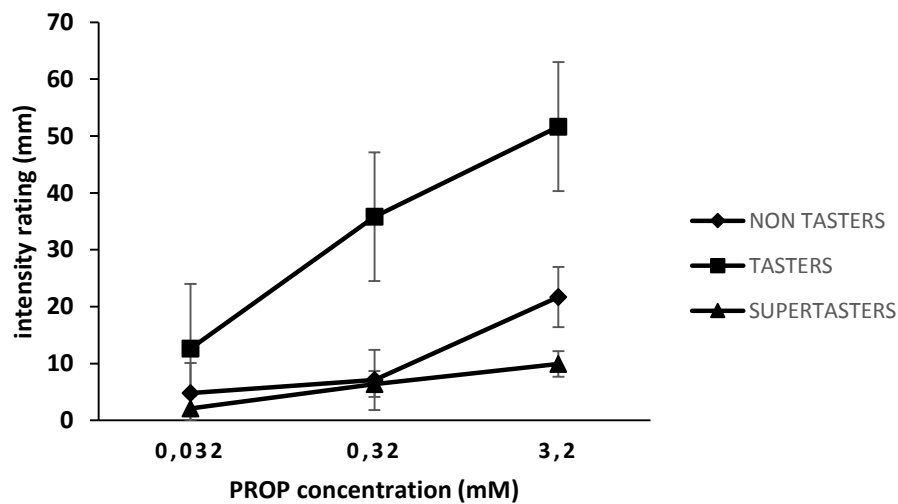


Figure 3.1. Bitterness intensity elicited by increasing concentrations of PROP (segments before elimination of Supertasters).

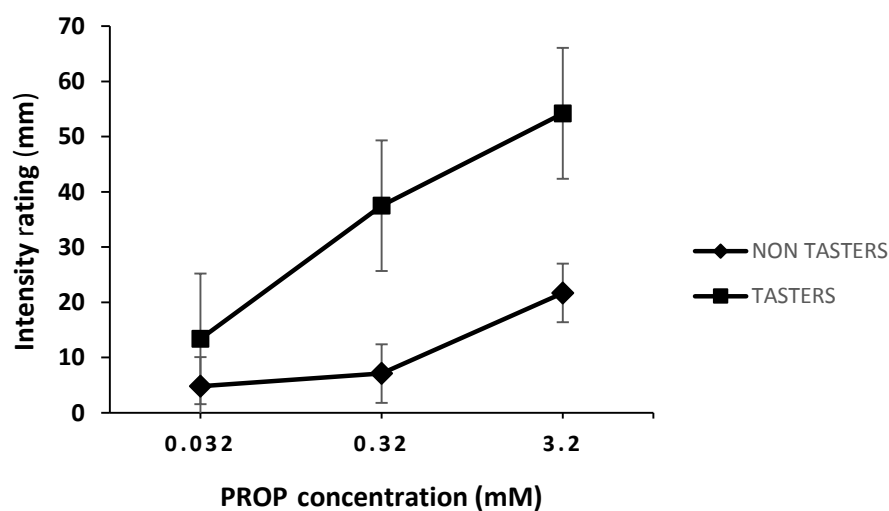


Figure 3.2. Bitterness intensity elicited by increasing concentrations of PROP (final panel division).

The majority of the tasters belong to the “Taster” class. According to Tepper et al. (2001), approximately 30% of the U.S. adult Caucasian population cannot detect any taste differences (they are taste blind to PROP, belonging to the non-tasters), while the other 70% consider the compound to be bitter (tasters). The supertasters, are claimed to occupy only the 25% of the population in comparison to the tasters, who represent the 50% of it (Bartoshuk, 2000). It is worth mentioning that, according to Bartoshuk et al. (1994), females are in general more likely to be the supertasters than males, as it was proved to have more fungiform papillae as well as more taste pores than males do. As expected however, the percentage of taster status varies among other populations. In agreement with the studies above, in our experiment there were two supertasters, both females, whom due to panel’s eliminations, we had to exclude one (because of repeated absences) and consequently, for practical reasons of data treatment, had to include the other in the tasters’ class. Therefore, we used two classes in PROP category: Non-Tasters and Tasters.

The average saliva weight was 2.39 g/min for the sum of the tasters, which was used as a cut-off value, to divide the panel according to their saliva production. High producers were those producing more than 2.39 g/min and low producers if the saliva flow was less than that amount referred.

The respondents were also divided into two additional categories, regarding their sweet liking preferences. The results were obtained by rating the liking of 205 g/l sucrose, cut-off value obtained by the past study of Assao et al. (2015), which showed that the majority of the respondents (20) were sweet dislikers, while only one third of them showed a positive response (8). Our results were in agreement with those of Assao et al. (2015), where 16 of the tasters were classified as SD and 10 as SL.

Finally, regarding the smell sensitivity, following the simultaneous work of Vitorino (unpublished), 17 of the tasters were classified as having low sensitivity, while a number of 11 showed a higher one, completing the panel characterization in terms of physiological characteristics. As far as we are aware, this kind of test was performed for the first time and so comparison with data from literature was not possible.

3.2 Sensory and hedonic evaluation of wine tastants

3.2.1 Distribution of intensity and liking scores

The responses of the tasting panel for each sugar, tartaric acid and tannic acid concentration in white wine are plotted in figure 3.3, regarding sensory and hedonic responses. The scores for each individual response are listed in annexes 3.1 to 3.3.

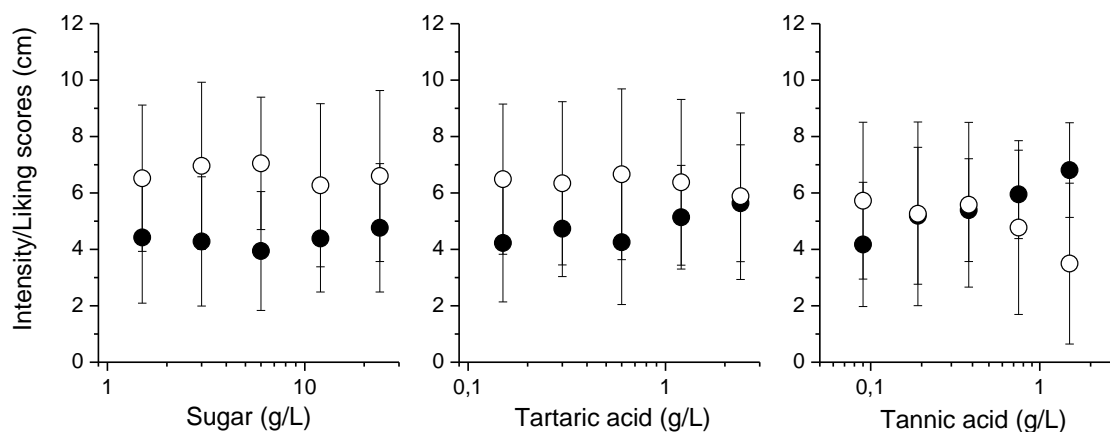


Figure 3.3. Mean intensity (●) and liking (○) scores for white wine spiked with increasing concentrations of sugar, tartaric acid and tannic acid. Horizontal bars indicate standard deviation of the mean.

The observation of the results evidences a large standard deviation reflecting the variability of the responses. We hypothesised that we could separate tasters in two segments, one with high response to the stimulus and the other with low response. Our first step was to obtain a measure of the individual sensory and hedonic response for each taster. For this, we determined the geometric mean of the scores across all stimulus concentration. The responses to sugar, tartaric acid and tannic acid given by the tasting panel are presented in Annex 3.5 concerning the geometric mean of individual intensity and liking scores. To evaluate the distribution of scores, histograms for each tastant gathering intensity and liking scores are shown in figure 3.4.

Observing the results presented in figure 3.4, we could say that regarding intensity scores, we found greater variations in tannic acid starting from relatively low scores and ending with higher ones, whereas in the case of tartaric there was a more homogenous scoring evolution. As for the sugar intensity scores, there was a peak reached right in the middle of the scoring, while the rest of the indications varied little. In the case of liking scores, again tannic acid showed the greatest variations, with diversity in scoring varying from quite low to quite high, tartaric acid and sugar this time vary a lot, comparing to the intensity scores, having indications starting very low, reaching a pick and again, dropping in low values.

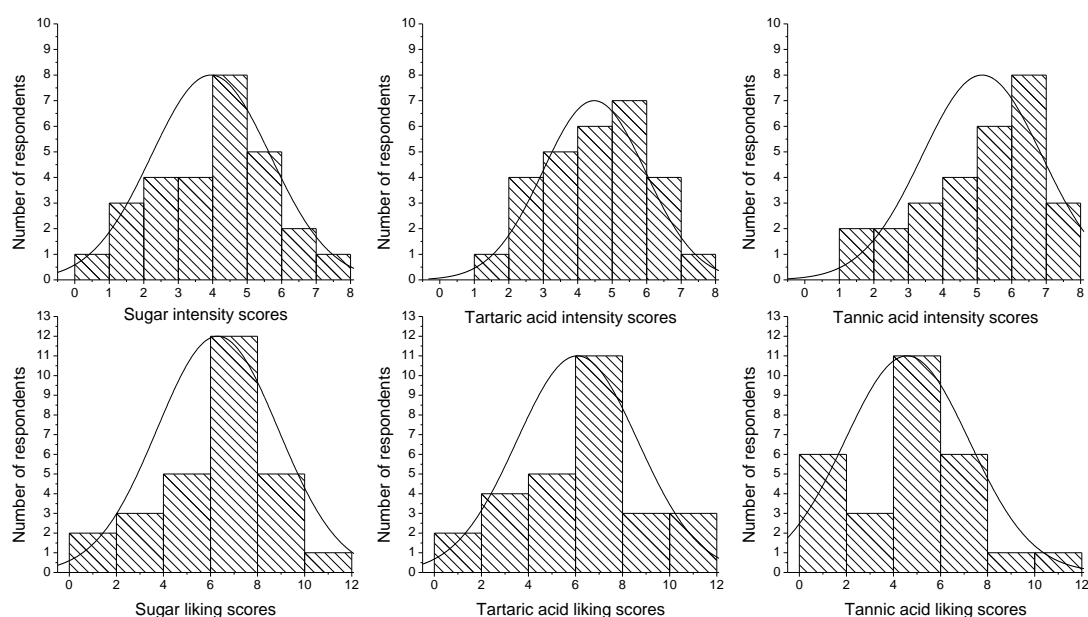


Figure 3.4. Distribution of the geometric mean of the intensity and liking scores given by tasters to white wine (Macabeu) spiked with increasing concentrations of sugar, tartaric acid and tannic acid.

The shape of the distribution of the graphs can be visually compared to a normal (Gaussian). Regarding intensity, sugar and tartaric acid responses the distribution is a little skewed to the left while the distortion was evident with tannic acid. In the case of tannic acid liking we observed what could be a bi-modal distribution, meaning that we could have two populations, one disliking astringency and the other constituted by likers. These results must be validated with a higher number of individuals.

3.2.2 Relation between intensity and liking scores

In order to check if there was a relation between sensitivity to the tastant and the respective hedonic evaluation, several correlations were determined and are shown in figure 3.5. The correlation coefficients were 0.28 (sugar), 0.18 (tartaric acid) and -0.27 (tannic acid). Considering that when $|r| < 0.3$ there is no correlation, the results indicate that hedonic appreciation is not determined by sensitivity to the tested tastants. If any, the sensory responses were only marginally contributing to the liking

responses. Therefore, we established new taster segmentations not based on intensity responses but on the liking scores of each individual, as explained below.

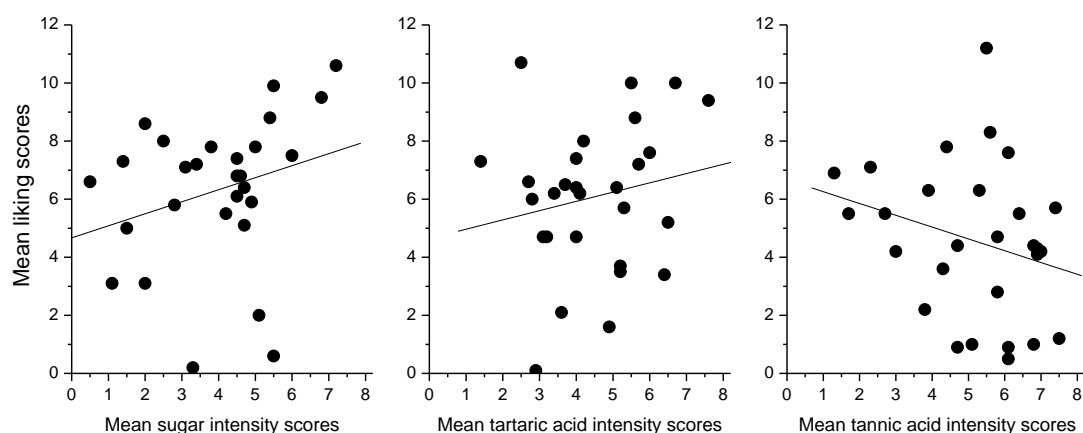


Figure 3.5. Correlations between intensity and liking geometric mean scores to each tastant in white wine. Straight lines were obtained by linear regression.

3.2.3 Consumer segmentation based on liking of white wine spiked with tastants

The tasters were divided in two segments for each stimulus according to an arbitrary cut-off value equal to the mean of each geometric mean (Grand mean). Those having a geometric mean response higher than the grand mean were considered high likers (HL) and those with lower response were considered low likers (LL). The average of each geometric mean for each individual was also determined as an overall response to all stimulus. The segmentation results are shown in table 3.4 and the distribution of all stimulus response is shown in figure 3.6.

The results distribution shows clearly that one taster gave consistently very low liking scores across all tastants and respective concentrations. To summarize the obtained segmentation groupings, table 3.6 shows the number of tasters according to each liking status.

This segmentation was used as an additional factor to find possible relations between the preference for the commercial wines with the liking of the different stimulus (sugar, tartaric and tannic acid) added to white wine.

Table 3.4. Taster segmentation according to the liking status of each tastant added to white wine (HL, high likers; LL, low likers).

Taster	Sugar		Tartaric acid		Tannic acid		All stimulus	
	Mean	Status	Mean	Status	Mean	Status	Mean	Status
1	7.8	HL	7.4	HL	4.4	LL	6.5	HL
2	6.5	HL	5.2	LL	4.3	LL	5.3	LL
3	5.8	LL	2.1	LL	1.0	LL	3.0	LL
4	8.8	HL	6.4	HL	4.4	LL	6.5	HL
5	7.2	HL	6.4	HL	4.2	LL	5.9	HL
6	0.2	LL	0.1	LL	0.9	LL	0.4	LL
7	5.5	LL	4.7	LL	3.6	LL	4.6	LL
8	0.6	LL	3.4	LL	2.8	LL	2.2	LL
9	7.4	HL	4.7	LL	1.2	LL	4.4	LL
10	6.8	HL	5.7	LL	4.1	LL	5.5	LL
11	8.0	HL	6.6	HL	7.1	HL	7.3	HL
12	6.8	HL	8.0	HL	6.3	HL	7.0	HL
13	5.1	LL	3.7	LL	2.2	LL	3.7	LL
14	8.6	HL	10.7	HL	4.7	HL	8.0	HL
15	3.1	LL	6.2	HL	0.5	LL	3.3	LL
16	6.6	HL	6.5	HL	6.9	HL	6.7	HL
17	9.9	HL	10.0	HL	8.3	HL	9.4	HL
18	2.0	LL	3.5	LL	1.0	LL	2.2	LL
19	7.1	HL	4.7	LL	4.2	LL	5.3	LL
20	5.0	LL	7.2	HL	7.8	HL	6.7	HL
21	10.6	HL	10.0	HL	5.5	HL	8.7	HL
22	7.5	HL	7.6	HL	7.6	HL	7.6	HL
23	9.5	HL	9.4	HL	5.7	HL	8.2	HL
24	3.1	LL	6.0	LL	5.5	HL	4.9	LL
25	7.8	HL	8.8	HL	11.2	HL	9.3	HL
26	6.1	LL	6.2	HL	6.3	HL	6.2	HL
27	7.3	HL	7.3	HL	5.5	HL	6.7	HL
28	5.9	LL	1.6	LL	0.9	LL	2.8	LL
Grand Mean	6.3	-	6.1	-	4.6	-	5.7	-

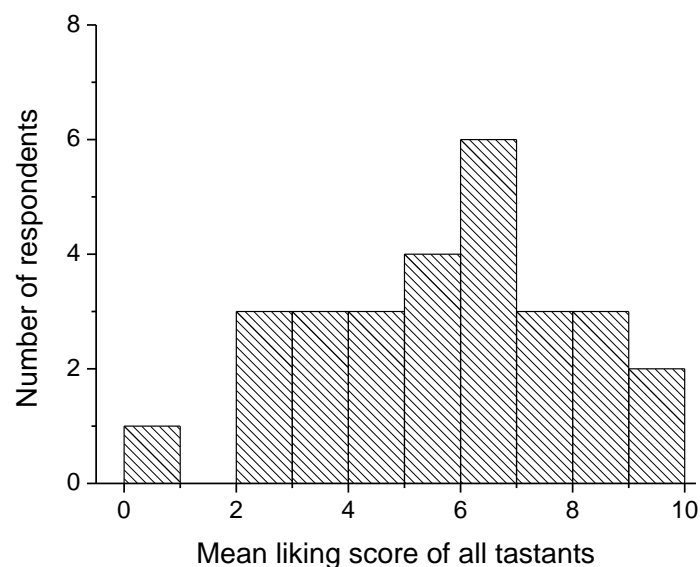


Figure 3.6. Distribution of the mean liking scores obtained from the geometric mean of the individual liking score for white wine spiked with sugar, tartaric acid and tannic acid.

Table 3.5. Number of respondents in each segment of stimulus liking status (HL, high likers; LL, low likers).

		Sugar		Tartaric acid		Tannic acid		All stimulus	
		HL	LL	HL	LL	HL	LL	HL	LL
Sugar	HL	17	-	13	4	10	7	13	4
	LL	-	11	3	8	3	8	2	9
Tartaric acid	HL	13	3	16	-	12	4	15	1
	LL	4	8	-	12	1	11	0	12
Tannic acid	HL	10	3	12	1	13	-	12	1
	LL	7	8	4	15	-	15	3	12
All stimulus	HL	13	2	15	0	12	3	15	-
	LL	4	9	1	12	1	12	-	13

3.2.4 Consumer segmentation based on sweet liking results

The tasters were divided in two segments, according to an arbitrary cut-off value of 205 g/L (as described in 2.3.4 obtained by the study of Asao et al. 2015) which they were requested to evaluate in terms of appreciation (liking). The evaluation was established by marking their answer in a 15 cm VAS scale, and the cut-off score used

to separate them to two segments, sweet likers and sweet dislikers was that of 7.5 cm (mid-point of the VAS scale). The results obtained led us to include 20 of the tasters into the segment of sweet dislikers and 8 in that of sweet likers, a result generally expected and in agreement with the study of Asao as described in 3.1.2. Complete panel results regarding sweet liking are presented in Annex 3.4

3.3 Evaluation of wines before and during food consumption

The ability of food pairing was evaluated with 4 commercial (originating in Greece and Portugal) wines through the establishment of ranking orders. The ranking sum results, obtained by the trained panel before and after food pairing, are summarized in table 3.7. The results were analyzed with several statistical methods. Observing the rank sums bellow, we noticed that the preference for the white wines (W1, W2) decreased after food consumption, in comparison to the one of reds (W3, W4), which increased after pairing. There was a tendency for the trained panel to rank in first places the white wines before combining them with the dish (with rankings 55 and 72), whereas after the food consumption, the red wines passed to the first places of rating and preference (68 and 64), showing that this food and red wine combination was more overwhelmed by the participants. The following tests will show that these differences were not significant.

Table 3.6. Rank sums for each wine, obtained by the trained panel, before and after food pairing.

		Before Food				After Food			
Wines		W1	W2	W3	W4	W1	W2	W3	W4
Rank sums		55	72	77	76	69	79	68	64

3.3.1 Friedman's test

For the trained panel, Friedman's test (F_{test}) was 6.728 before food and 2.614 after food consumption. Both values were below 7.81 (critical value F for the Friedman's test with significance level of $\alpha=0.05$, for more than 20 tasters, ISO 8587), concluding that there were no differences among the rank order.

To conclude, by using rank orders, it was not possible to establish a difference in preferences for the four wines, therefore we proceeded into further statistical

applications to obtain a clearer outcome regarding the influence of food pairing on wine perception by the tasters.

3.3.2 Pearson's X^2 test evaluation

In order to apply the Pearson's X^2 test to the trained panel, we calculated the probability associated to the number of changes in wines' classification, establishing the possible changes in the ranking of the 4 tasted wines, if changes occur randomly. We concluded that the number of changes that could occur if the distribution was random could be 0, 3, 4, 6 or 8 with an associated probability of 1/24, 3/24, 7/24, 9/24 and 4/24, respectively. These values correspond to the null hypothesis of the test and are presented in table 3.8 (π_i). The distribution of the changes in wines' classification observed for the 28 tasters is shown (O_i).

Table 3.7. Probabilities, observed values and expected values for the trained panel.

	0	2	4	6	8
π_i	$\frac{1}{24}$	$\frac{1}{8}$	$\frac{7}{24}$	$\frac{3}{8}$	$\frac{1}{6}$
O_i	0	7	7	12	2
$E_i (\pi_i \cdot N)$	1.17	3.5	8.17	10.5	4.7

The statistics calculations were the following:

$$X^2_{calc} = \frac{(0 - 1.17)^2}{1.17} + \frac{(7 - 3.5)^2}{3.5} + \frac{(7 - 8.17)^2}{8.17} + \frac{(12 - 10.5)^2}{10.5} + \frac{(2 - 4.7)^2}{4.7} = 6.603$$

$$X^2_{(4)0.05} = 9.4877$$

The value of X^2_{calc} is lower than $X^2_{(4-1)0.05}$, therefore the null hypothesis was not rejected (with $\alpha=0.05$). This indicates that the probabilities were not different from those corresponding to changes randomly assumed, that leads us to conclude that food consumption did not have a real influence on wine appreciation.

3.3.3. Evaluation through the Spearman correlation coefficient

In order to study the agreement between two rank orders (for example, rankings by assessors or an assessor's rank order and an order predicted by information about the samples), one can calculate the Spearman correlation coefficient, r_s (ISO 8587). The values of Spearman Coefficients are shown in Figure 3.7 for each of the tasters. We observed that only four tasters were below 0 (with 2 of them < -0.5), which means that only these four showed (clear) changes after food consumption, while the rest (24) were above 0, indicating that the rank orders were kept after pairing. As a conclusion, we observed that there was a tendency from the participants to maintain their ranks similar (table 3.8).

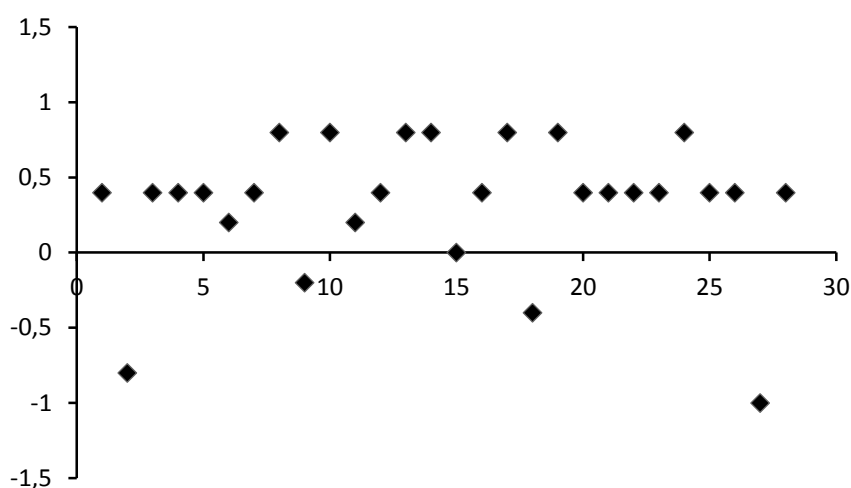


Figure 3.7. Results from the Spearman's test for the trained panel.

Table 3.8. Spearman Correlation Coefficient of the trained panel.

Spearman Correlation Coefficient	Nº of tasters
-1	1
-0.8	1
-0.4	1
-0.2	1
0	1
0.2	2
0.4	14
0.8	7

After establishing the statistical tests mentioned above, and observing the obtained results, we conclude that the food consumption did not have influence on the appreciation of the four tasted wines. It's hard to comment and discuss on all the obtained results, as almost all the past similar studies have been established in quite different conditions (see table 1.2). For instance, in the case of Koone et al. (2014) as well as in Harrington & Seo (2015) there were mainly sweet wines used (Port and Ruby Port) whereas we used only dry ones. To sum up, the only differences we observed in our results, which were not such significant but it's more accurate to be mentioned, were among the demographic segmentation, specifically in the case of smoking habits, where regarding only the first wine (Greek Malvasia), we observed minor differences after food pairing, which are not as significant to be analysed though. A similar phenomenon was observed when running the statistical analysis in the case of "neophobia" segmentation (conservative – non-conservative tasters). After statistically analyzing the data, we observed some differences concerning the sum of the ranking differences, having always as indicator Question 3, the only question that actually influenced the difference among the ranking. Contrarily to all the other consumer categories that gave a $p > 0.05$, in this case we obtained a $p = 0.0452$, with an F value of 4.429. However, the differences were not significant enough to be analyzed further, leading us to the conclusion that the whole wine appreciation process, was more affected by psychological characteristics, than physiological attributes.

4. Conclusions and future perspectives

Following the objectives of this study, we observed and analyzed the evaluation of three sensations, acidity, astringency and sweetness in white wine. The evaluation, covering both aspects of intensity and hedonic appreciation, provided us with interesting results. More specifically, we concluded that the trained panel showed greater variations in their responses to the tannic acid, with a larger number of individuals being high sensitive. In the case of tartaric acid and sucrose, the responses followed an apparent normal distribution. It would be interesting to explore if responses to astringency, a touch sensation, could be also dependent on individual genotype comparable to the PROP taste function responsiveness. Perhaps, the response to tannic acid is bi-modal having one population sensitive and another insensitive to astringency, as well as concerning liking.

Concerning the influence of food on wine appreciation, we achieved intriguing results that should be further explored. Having as samples 4 very different commercial wines, originating in Greece and Portugal, we noticed that the preference for the two white wines tended to decrease after food consumption, in comparison to the one of reds, with inverse tendency after pairing. The tasters showed a more positive response to the red wines when it came to combine them with the Cretan cold dish. White wines were more highly appreciated when tasted separately, without any edible accompaniments. However, when statistically analyzed, the ranking of the wines did not offer significant differences. This was due to the fact that the different directions of individual preferences cancelled the overall response of the panel. This outcome led us to seek for any individual feature that could predict wine liking. In addition to the conventional taster categories related with demographic, physiological or preference features, we added the categories of sweet liking, smell sensitivity and “neophobia”. The results showed that wine preference could only be related with this last psychological factor. The majority of the respondents were not willing to try particular styles of wine, showing their doubts and distrust among new and innovative ways of producing wine, or even wines from different cultures. Specifically, 19 out of 28 tasters were classified as “conservative” whereas only 9 were characterized as “non-conservative”. This result could be possibly used for further future studies, emphasizing on why young people nowadays seem to feel uncomfortable with exploring new pathways of wine tastings, accepting different styles, production ways and origins of wine, remaining instead strictly attached to what they have already been familiar with and subjected to mainstream opinions.

As a general conclusion, when it comes to wine tasting with food, every relation behind the final matching should be understood and analyzed separately. Our senses of smell and taste show a wide range of variation and, if any, have only a marginal effect on wine liking. Hedonic appreciation seems to be more related with our cultural, social and psychological background that shape our way of experiencing unfamiliar wine styles. The outcome of our work may well set the grounds for a different approach to the studies of wine appreciation where focus should be put more on those personal features, than on the abilities to sense and describe wine sensory characteristics.

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External Links

All about greek wine – Winemaking Regions (2010)

<http://www.allaboutgreekwine.com/regions.htm>

International Dairy Deli Bakery Association (2013) – Training materials

<https://www.iddba.org/training-materials/pdfs/jg-paircheese.aspx?ext=.pdf>

Wine in Moderation – Art de Vivre (2013): History % Tradition of Wine: Celebrating moderation.

<https://www.wineinmoderation.eu/en/content/History-Tradition-of-Wine.4/>

Appendix I – Trained panel test complete information

Table I.1 – Demographic characterisation of the trained panel

Name	Gender	Country	Age	Vegetarian	Food Allergy	Smoker
1	Female	Portugal	24	No	No	Yes
2	Female	Portugal	21	No	No	No
3	Female	Portugal	22	No	No	No
4	Male	Portugal	23	No	No	No
5	Female	Portugal	23	No	No	Yes
6	Female	Portugal	37	No	No	No
7	Male	Portugal	23	No	No	Yes
8	Female	Portugal	23	No	No	Yes
9	Female	Portugal	24	No	No	No
10	Female	Portugal	21	No	No	Yes
11	Female	Portugal	23	No	No	Yes
12	Male	Portugal	22	No	No	No
13	Male	Brasil	30	No	No	No
14	Male	Portugal	23	No	No	Sometimes
15	Female	Portugal	21	No	No	Yes
16	Female	Portugal	24	No	No	No
17	Female	Germany	25	No	No	Yes
18	Male	Portugal	23	No	No	Sometimes
19	Male	Portugal	23	No	No	Yes
20	Male	Portugal	23	No	No	Sometimes
21	Female	Portugal	23	No	No	Yes
22	Male	Portugal	23	No	No	No
23	Male	Portugal	23	No	No	No
24	Male	Portugal	24	No	No	No
25	Female	Portugal	21	No	No	No
26	Female	Portugal	40	No	No	No
27	Male	Portugal	23	No	No	Sometimes
28	Female	Portugal	26	No	Yes	No

Table I.2 – Physiological, vinotype and neophobia characterisation of the trained panel

Name	Saliva Status	PROP Status	Sweet Liking	Smell Sensitivity	Vinotype	Neophobia
1	Low	Non –Taster	Disliker	Low	Hypersensitive	Conservative
2	Low	Non –Taster	Liker	Low	Sensitive	Non-Conservative
3	Low	Non –Taster	Disliker	High	Tolerant	Conservative
4	Low	Non –Taster	Liker	Low	Sensitive	Conservative
5	High	Non –Taster	Liker	High	Hypersensitive	Conservative
6	High	Non –Taster	Disliker	High	Tolerant	Non-Conservative
7	High	Non –Taster	Liker	Low	Tolerant	Conservative
8	Low	Non –Taster	Disliker	Low	Hypersensitive	Non-Conservative
9	Low	Non –Taster	Disliker	High	Hypersensitive	Non-Conservative
10	Low	Non –Taster	Liker	High	Hypersensitive	Conservative
11	Low	Taster	Disliker	Low	Sensitive	Conservative
12	Low	Taster	Disliker	High	Sensitive	Conservative
13	High	Taster	Disliker	High	Tolerant	Conservative
14	High	Taster	Liker	Low	Hypersensitive	Conservative
15	Low	Taster	Disliker	Low	Hypersensitive	Conservative
16	Low	Taster	Disliker	Low	Sensitive	Non-Conservative
17	High	Taster	Disliker	High	Sensitive	Non-Conservative
18	High	Taster	Disliker	High	Hypersensitive	Conservative
19	Low	Taster	Disliker	Low	Sensitive	Conservative
20	Low	Taster	Liker	Low	Sensitive	Non-Conservative
21	High	Taster	Disliker	High	Sensitive	Conservative
22	High	Taster	Disliker	High	Sensitive	Conservative
23	High	Taster	Disliker	High	Sensitive	Conservative
24	High	Taster	Disliker	Low	Sensitive	Conservative
25	Low	Taster	Disliker	Low	Sensitive	Non-Conservative
26	Low	Taster	Disliker	Low	Sensitive	Non-Conservative
27	Low	Taster	Liker	High	Sensitive	Conservative
28	High	Taster	Disliker	Low	Sensitive	Conservative

Appendix II – Commercial Wines - Analysis

	Free SO ₂ (mg/L)	Total SO ₂ (mg/L)	pH	Total acidity (g/L tartaric acid)	Volatile acidity (g/L acetic acid)	Alcohol Strength (%v/v)	Reducing sugars (g/L)
Wine 1: Hatiri, Alexakis, Crete	-	80	3.31	4.9	0.28	13	1.5
Wine 2: Explicit, Rosa Santos, Alentejo	-	99	3.44	5.4	0.42	13.6	0.7
Wine 3: Kariki, Alexakis, Crete	-	86	3.5	5.6	0.43	12.4	1.9
Wine 4: Têmpera, Bento dos Santos, Lisboa	20	121	3.54	5.4	0.69	14.1	0.6

Annex 3.1.1 – Intensity and Appreciation of sucrose results

	Intensity					Appreciation				
	1.5 g/L	3 g/L	6 g/L	12g/L	24 g/L	1.5 g/L	3 g/L	6 g/L	12 g/L	24 g/L
1	5.3	5.7	3.4	5.5	5.4	7.2	7.8	7.2	8.2	8.5
2	7.2	2.2	6.4	3.4	6.4	4.9	4.4	7	6.9	10.4
3	3.9	3	2.1	3.3	2.2	4.4	4.5	8.3	4.9	8.3
4	7.3	8.1	5.6	4	3.4	5.6	9.7	9.2	9.4	11.1
5	4.8	3.7	2.3	5.5	2.1	7.2	7.7	7.3	6.4	7.3
6	5	4	5	4.6	0.8	1.4	1.3	1.7	0.7	0
7	5.5	4.5	2	5.3	4.7	5.3	3	8	4.6	8.3
8	6.3	5	4.3	7.5	5	2.7	5.5	8.8	0	4.3
9	4.4	3.1	6.4	3.1	7	8	11.6	5.1	10.6	4.3
10	4.8	7.3	4.2	5.7	2.2	4.6	8.6	7.3	6.7	7.7
11	6.6	7.7	3	2.3	5.8	6.9	5.8	7.7	7.8	6
12	5.8	6.6	2.5	4.4	5.2	5.3	7.5	3.8	6.3	3.8
13	1.6	1.1	4.9	1.5	2.7	9.4	5.2	11	7.7	11.4
14	5.1	3.2	1.5	1.1	1.1	1	4.6	4.2	3.4	4.7
15	0.2	2	0	3.2	2	7.2	6.5	7.5	4.6	7.8
16	4.1	3.5	6.7	6.7	7.8	10.6	10.4	9.9	9.9	8.9
17	5.9	5.6	3.3	4.6	7	3.5	1.5	4.8	0.9	1.3
18	1.9	4.8	3.2	2.7	3.5	7.7	7.1	6.8	7.3	6.7
19	0.1	3	0.5	5.5	9.1	7.2	6.4	6.7	7	1.4
20	7	7.4	7.4	7	7.4	9.3	10.6	11.2	10.1	11.8
21	5.2	5.4	4.9	7.3	7.7	9.2	8.5	7.4	6.8	5.9
22	7	7.1	6.9	6.8	6.2	10.5	10.5	8.6	10.4	8
23	0.5	1.1	2.3	0.4	2.9	6.2	2.5	3.6	1.5	3.5
24	6.4	1.2	7.9	2	6.5	9.1	6.8	10.2	5.1	8.8
25	5.4	6.1	3.9	4.7	3	5.6	6.8	6.7	8	4.2
26	0.2	0.8	1.3	4.6	5.5	7.4	7.8	7.6	6.9	7
27	5.2	6	4.7	4.7	4	4.9	9.5	3.1	6.4	7.9
28	1.1	0.7	3.8	5.4	6.8	10.3	12.8	6.7	7	5.4
Mean	4.5	4.4	3.9	4.3	4.7	6.3	6.7	7	6.2	6.6

Annex 3.1.2 – Intensity and appreciation of increased concentrations of sucrose results

	Intensity					Appreciation				
	6 g/L	12 g/L	24 g/L	48 g/L	96 g/L	6 g/L	12 g/L	24 g/L	48 g/L	96 g/L
1	5.3	6.4	3	6.7	5.4	6.2	4.5	7.7	5.6	7.3
2	4.7	4.8	3.5	4.7	5.4	5.4	4.3	6.8	9	8.9
3	3.1	3.3	1.7	5.9	3.9	6.2	7	6.7	4.4	5.3
4	4.7	2.8	3.1	3.5	1.8	5.8	4.3	8.3	7.2	6.8
5	6.4	3.6	2.9	5.8	3.8	4.6	7.3	8.9	8.8	8.8
6	1.5	1.8	0.9	0.6	0.6	7.4	6.3	2.3	0.5	0.1
7	2	2.4	3.1	3.2	4.4	4.2	4.1	7.8	7.2	7.8
8	7.4	1.3	5	7.4	6	1.9	9	6.2	1.8	3.9
9	1.4	1.8	2.9	4.7	6.5	11.8	10.9	10	8.2	7.1
10	3.3	4.5	2.9	4.3	2.7	2	3.5	2.7	4.4	3.3
11	0.2	0.1	2.3	3.2	3.2	7.6	7.2	7.1	7	6.3
12	1.8	2.8	5	7.1	8.2	2.1	7.2	7.5	5.8	4.7
13	0.4	0.7	5.1	5.3	4.1	0.6	2.3	4	0.7	3.9
14	1.7	1.4	2.8	2.2	4.3	8.1	7	2.8	3.1	1.3
15	3.8	2.7	1.5	4.4	4.7	7.4	8.6	8.3	7.2	6.6
16	1.3	1.7	5.7	6.5	8	10.4	10.6	10.5	8	4.2
17	6	4	8.1	0.4	9.5	3.5	4	1.5	0.4	0.3
18	0.7	0.2	5.4	6.2	6.4	7.7	8.3	3.3	1.1	0.4
19	3.3	2.4	7.8	8.5	9.6	8.3	9.6	4.7	3.8	1.5
20	6.3	5	6.4	7.4	7.5	7.5	8.5	11.2	9	11.8
21	5.2	6.3	6.1	7.5	7.9	7.3	6.3	4.7	2	1.7
22	7.4	7.2	5.4	3.7	3.6	10.3	10.8	7.9	4.4	5.6
23	1	1.5	2.3	1	1.3	4.1	3.3	4.6	3.7	3.9
24	3.8	4	6.6	6.1	8.4	8.6	8.4	7.6	7.2	6.9
25	5.8	5.5	4.2	4.5	4.7	5.1	7.3	7	4.9	4.7
26	1.1	1.5	3.3	4.5	5.5	9.7	10.1	8.8	7.3	6
27	5.3	6.7	4.8	6.3	5.4	3.5	7	8.1	6.1	5.1
28	2.7	1.2	8	9.5	9.7	10.4	11.9	3.5	0.4	0.5
Mean	3.49	3.13	4.28	5.04	5.45	6.35	7.13	6.45	4.97	4.81

Annex 3.2 – Intensity and Appreciation of tartaric acid results

	Intensity					Appreciation				
	0.15 g/L	0.3 g/L	0.6 g/L	1.2 g/L	2.4 g/L	0.15 g/L	0.3 g/L	0.6 g/L	1.2 g/L	2.4 g/L
1	4.4	6.5	1.5	6.4	3.6	8	6	9.9	6.5	7
2	4.4	4.7	8.2	7.1	7.9	5.9	5.8	6	4.2	4.5
3	4	4	3	3	4.2	3.2	0.5	3.2	3.4	2.4
4	5.3	5.4	4.8	5.4	4.7	9	6.4	5	7.2	5.2
5	5.7	3.9	2.9	3.7	4.4	6.6	6.1	6.7	7.1	5.6
6	2.5	4.6	2.5	1.9	3.5	3.2	0.9	0.5	0	0.2
7	1	4.8	2	5.3	5.4	4.9	9.2	4.3	3.4	3.4
8	7.5	5	6.3	6.3	7.1	1.1	6.6	3.2	5.8	3.4
9	6	0.8	3.6	7.8	8	4.4	11.7	8.4	1.3	4.3
10	3.5	5.2	6.3	5.4	6.9	4.4	6.4	5.2	7.2	5.6
11	6.1	7	4.5	1.4	5.1	8	7.4	7.5	9.6	7.8
12	3.4	5.4	5.5	5	7.4	3.5	5.9	4	4.5	1.8
13	2.6	1.7	2.7	4.2	2	11.5	8.2	11.4	11.5	11.5
14	4	4.4	4.5	4.5	3.2	6.7	8.9	3	10.6	4.8
15	2.7	6.1	2	5.8	3.7	7.5	5.2	8.7	4.9	6.8
16	6	6.7	5.6	7.1	3.2	10.8	10.4	9.2	8.4	11.8
17	3	6	5.4	5.6	6.8	7	0.7	7.5	3.4	4.5
18	2.5	4.8	1.1	3.7	6.7	4.5	4.4	5.4	5.5	3.7
19	8.4	2.1	7.2	5.3	9	5.5	7.9	6.6	8.8	7.5
20	6	6.4	7.5	6.1	7.7	9.2	8.9	13	9	10.5
21	7.1	2.7	6.3	7.6	8.4	6.9	8.2	10.3	6.2	7.1
22	7.4	7.4	7	8	8.3	9.6	9.3	8.5	10.2	9.4
23	2.4	2.4	2.4	2.7	4.7	5.7	4	7.8	5.4	7.9
24	2.7	6	6.8	6.1	8	9	8.1	10	8.5	8.7
25	2.8	5.7	4.1	3.8	1.9	5.8	5.8	8.8	7	4.5
26	0.2	3.7	1	2	4.1	11.2	7	6.5	7.2	5.5
27	3.6	6.1	3.9	5.5	5.8	3.1	0.9	1.7	1.8	1.4
28	2	3	0.5	7.2	6.1	5.5	6.8	4.2	10	8
Mean	4.3	4.8	4.4	5.0	5.6	6.5	6.3	6.7	6.2	5.8

Annex 3.3 – Intensity and Appreciation of tannic acid results

	Intensity					Appreciation				
	0.9 g/L	0.18 g/L	0.38 g/L	0.75 g/L	1.5 g/L	0.9 g/L	0.18 g/L	0.38 g/L	0.75 g/L	1.5 g/L
1	6.7	7.6	5.9	7	6.7	5.2	7	3.3	7	2
2	7.1	6.4	6.7	6.1	8.3	3	5.3	5.8	5	3
3	6.2	8.8	5.3	7.9	6.5	1.1	0.6	2.3	0.6	1.2
4	4.1	6.8	3	6.3	4.4	6.3	4.1	5	5	2.7
5	6.5	8.1	6.3	7.6	6.6	5.1	3	5.2	3.4	4.6
6	4.9	5.7	5.9	2.5	5.7	3.8	2.5	1.6	0.2	0.2
7	2	3.8	6.2	4.2	7.1	5	8.5	3.2	6	0.7
8	5	7.1	5	4.7	8.1	3.8	1.9	3.2	3.8	1.8
9	5.5	6.9	8.8	7.7	9.1	8	2.1	0.5	0.7	0.5
10	7.1	6.7	6.3	7.5	7.2	4.1	6.6	3.6	6.8	1.7
11	2.2	2	5.7	4.8	7.7	9.2	8.5	4.7	7.7	3.5
12	0.5	5.8	5.5	6.2	7.5	7.5	1.9	2.5	1.5	1
13	5.5	4.8	3.9	7.8	8.2	4	4	10	3.5	4
14	5.5	7.7	4.2	7.2	6.5	1	0.1	3	0.2	0.4
15	1.1	1.8	0.5	2	1.9	7.4	7.3	7.4	6.4	6.2
16	4.7	3	6.5	8.1	7.3	9.8	10.8	9.9	4.8	8
17	3	7.1	3.8	6.6	6.5	2.6	0.3	5.5	0.6	0.4
18	0.4	4.5	3.7	6.5	5.9	6.8	4.1	6.9	1.7	4.2
19	3	4.2	3.2	5.2	8	6.5	9.5	7.1	8.6	7.9
20	6	6.2	7.4	5	8	5.5	5.5	10.1	6.1	2.6
21	6	5.3	7.7	4.8	7.1	7.7	8	7	8.3	7
22	5.6	7.9	7.3	7.7	9.2	8.2	8.4	10.2	4.2	2
23	1.6	0.3	2.1	4.8	2.8	3.5	4	5.8	7.8	7.8
24	4.3	4	7.3	4.8	8.3	11.6	11.5	10.7	11	11
25	4.6	5.5	5.3	6.1	5.3	5.6	6.5	7.7	6.3	5.7
26	1	0.7	5.3	5.2	7.7	7.7	7.1	4.6	7	2.9
27	6.2	6.3	6	6.2	6	0.6	1	1.8	0.7	0.8
28	0.6	0.4	6.2	6.1	7.1	9.4	7.2	7.7	8.7	4.1
Mean	4.3	5.3	5.3	5.9	6.8	5.6	5.1	5.5	4.6	3.4

Annex 3.4 – Sweet Liking results (Sucrose concentration 205 g/L)

	Appreciation
	205 g/L
1	5.7
2	8.6
3	6.2
4	7.5
5	13
6	0.5
7	8.8
8	5.7
9	7.1
10	9.5
11	5.6
12	4.7
13	1
14	10.7
15	3.3
16	5.2
17	0.4
18	2
19	3.3
20	13.2
21	2.7
22	3.4
23	3.3
24	6.3
25	4.2
26	4.4
27	10.5
28	4.2
Mean	5.8

**Annex 3.5 - Geometric mean of the intensity and liking scores
of each taster regarding white wine spiked with increasing
concentrations of sugar, tartaric acid and tannic acid.**

Taster	Sugar		Tartaric acid		Tannic acid	
	Intensity	Liking	Intensity	Liking	Intensity	Liking
1	5.0	7.8	4.0	7.4	6.8	4.4
2	4.7	6.4	6.5	5.2	6.9	4.3
3	2.8	5.8	3.6	2.1	6.8	1.0
4	5.4	8.8	5.1	6.4	4.7	4.4
5	3.4	7.2	4.0	6.4	7.0	4.2
6	3.3	0.2	2.9	0.1	4.7	0.9
7	4.2	5.5	3.1	4.7	4.3	3.6
8	5.5	0.6	6.4	3.4	5.8	2.8
9	4.5	7.4	4.0	4.7	7.5	1.2
10	4.5	6.8	5.3	5.7	6.9	4.1
11	4.6	6.8	4.2	8.0	3.9	6.3
12	4.7	5.1	5.2	3.7	3.8	2.2
13	2.0	8.6	2.5	10.7	5.8	4.7
14	2.0	3.1	4.1	6.2	6.1	0.5
15	0.5	6.6	3.7	6.5	1.3	6.9
16	5.5	9.9	5.5	10.0	5.6	8.3
17	5.1	2.0	5.2	3.5	5.1	1.0
18	3.1	7.1	3.2	4.7	3.0	4.2
19	1.5	5.0	5.7	7.2	4.4	7.8
20	7.2	10.6	6.7	10.0	6.4	5.5
21	6.0	7.5	6.0	7.6	6.1	7.6
22	6.8	9.5	7.6	9.4	7.4	5.7
23	1.1	3.1	2.8	6.0	1.7	5.5
24	3.8	7.8	5.6	8.8	5.5	11.2
25	4.5	6.1	3.4	6.2	5.3	6.3
26	1.4	7.3	1.4	7.3	2.7	5.5
27	4.9	5.9	4.9	1.6	6.1	0.9
28	2.5	8.0	2.7	6.6	2.3	7.1

Appendix III – Tasting sheets

Sheet III.1 – Demographic information – Saliva test

Date __/__/__

Name _____

Age _____ Gender (F/M) _____ Country _____

Study Background _____

Smoker (Y/N/Sometimes) _____ Vegetarian (Y/N) _____ Food Allergy (Y/N) _____

Vinotype _____

Wine Expertise

I don't drink wine

Beginner

Intermediate

Very high

Saliva Flow

Taste the sample given to you, hold it in the mouth for 10/15 seconds. Spit it out. Hold for another 10 seconds and spit in the plastic cup for a minute.

Initial Weight

Total Weight

Saliva Weight

Sheet III.2 – Evaluation of Sensations

Date__/__/__

Name _____

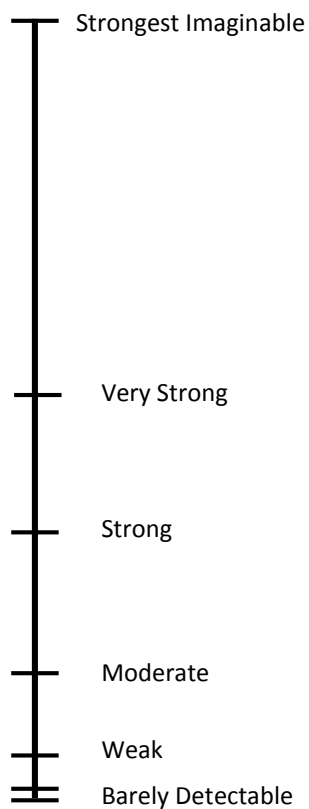
Imagine having the following five sensations:

- 1) Sourness of a lemon;
- 2) Pain from biting your tongue;
- 3) Coolness of an ice-cold beverage;
- 4) Burning sensation from eating a whole hot pepper;
- 5) Brightness of the sun when you are looking directly at it.

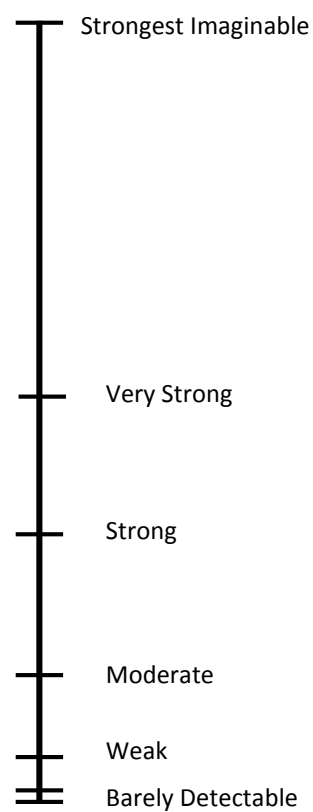
Please rate the intensity of the five remembered sensations by drawing a horizontal line across each scale.

Write down the most intense sensation in any modality that you could ever imagine experiencing.

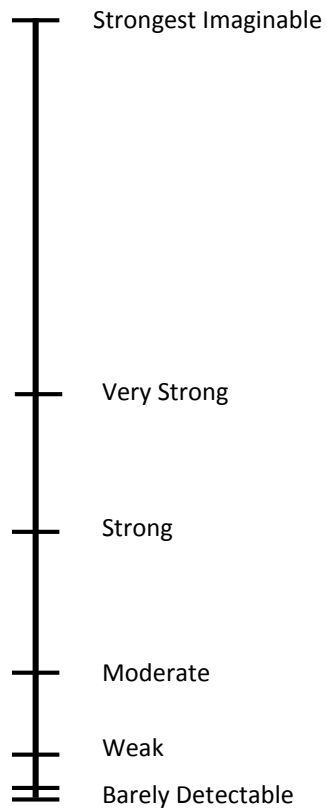
1) Sourness of a lemon



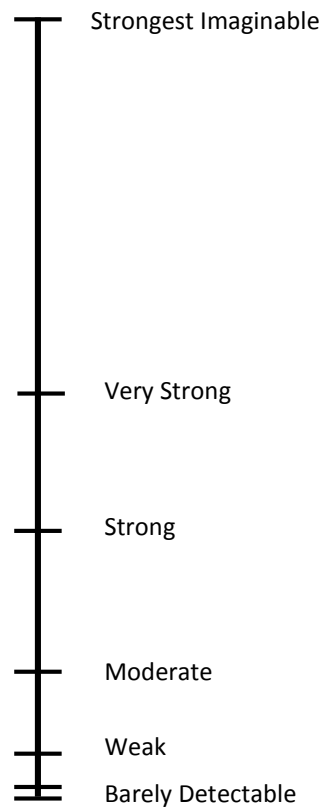
2) Pain from biting your tongue



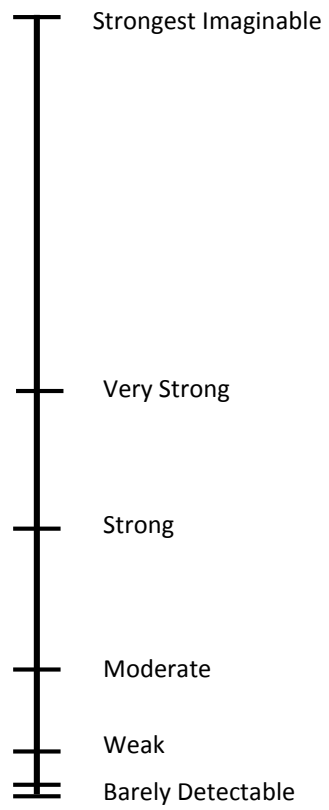
3) Coolness of an ice-cold beverage
pepper



4) Burning sensation from eating a whole hot
pepper



5) Brightness of the sun when you are looking directly at it






Sheet III.3 – PROP & NaCl evaluation

Date__/_/____

Name _____

Rinse with water before beginning. Put the sample in the mouth, rinse for 10 seconds, being sure that you cover all the mouth surfaces and wait for the sensation intensity to peak (10-15 s). The maximum intensity is 10 seconds after spiting. After you taste the first sample rate the intensity of the sensation by drawing a mark on the LMS Scale. Rinse with spring water and wait 1 minute between samples. Repeat the same procedure with the other 2 samples.

		
<div data-bbox="201 1641 308 1722" style="border: 1px solid black; padding: 5px; text-align: center;">432</div>	<div data-bbox="673 1641 780 1722" style="border: 1px solid black; padding: 5px; text-align: center;">176</div>	<div data-bbox="1123 1641 1230 1722" style="border: 1px solid black; padding: 5px; text-align: center;">891</div>

Sheet III.4 – Intensity & Appreciation of tastants

Date ____/____/____

Name _____

Rinse with water before beginning. Put the sample in the mouth, rinse for 10 seconds, being sure that you cover all the mouth surfaces and wait for the sensation intensity to peak (10-15 s). The maximum intensity is 10 seconds after spiting. After you taste the first sample rate the intensity of the sensation by drawing a mark on the intensity scale. After, draw a mark on the liking scale according to your personal preference. Rinse with spring water and wait 1 minute between samples. Repeat the same procedure with the other samples.

Intensity



Liking



Sheet III.5 – Sweet Liking

Name

Put the separate sample in the mouth, rinse for 10 seconds, being sure that you cover all the mouth surfaces and wait for the sensation to peak (1—15s.) The maximum intensity is 10 seconds after spiting. After, draw a mark on the liking scale according to your personal preference.

Liking

Dislike extremely

Like extremely

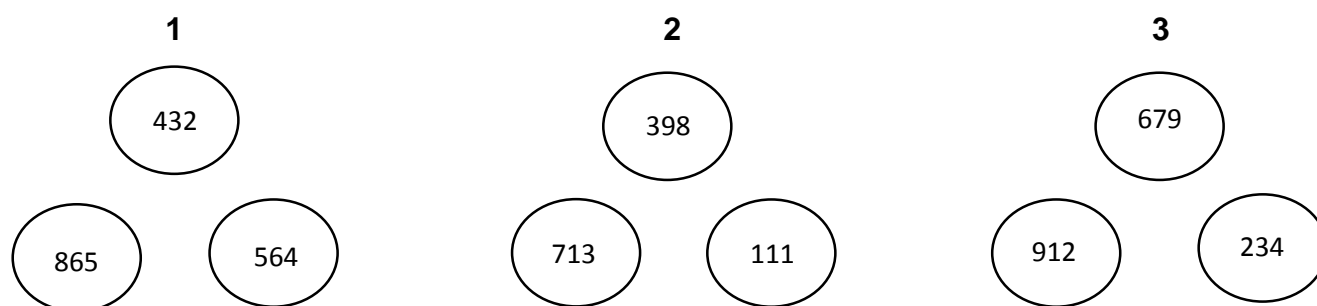


Sheet III.6 – Triangle test (Tastants used: Sucrose, Tartaric acid, Tannic acid)

Date __/__/__

Name _____

Please taste each triangle set and try to identify which one of the three glasses has the different content (two of the three glasses in each set are completely similar). Write down the different sensation that you receive. Note that even if you are not able to identify the different glass, you should choose one in any case. Please try to complete each triangle set in one repetition, and avoid coming back, as it might lead you to confusions.



	<u>N° of the different glass</u>	<u>Different perceived taste</u>
<u>1</u>		
<u>2</u>		
<u>3</u>		

Sheet III.7 – Food pairing test (Ranking of wines) & Neophobia questionnaire

Name: _____

Date: _____ Vinotype: _____

Please taste the samples. Rinse with water between each sample. Evaluate each wine sample according to your preference (1st place corresponding to the favorite to 4th the least favorite one)

1st Place: _____

2nd Place: _____

3^d Place: _____

4th Place: _____

Now, taste the wines again, this time combining them with the food served. Taste the wine and the food two times, then after the third tasting of the wines evaluate each wine sample, according to its ability in being paired with food. Which combination is most preferable according to your opinion? Write down your answer starting with the most pleasant combination and finishing with the less preferable as in the above. (1st place corresponding to the favorite to 4th the least favorite one)

1st Place: _____

2nd Place: _____

3^d Place: _____

4th Place: _____

Please answer the following questions, by choosing either yes or no.

- | | |
|---|--------|
| 1. I am certainly tasting new wines. | YES/NO |
| 2. I like wines from different countries. | YES/NO |
| 3. Particular wines (e.g. orange) look weird to taste. | YES/NO |
| 4. At dinner parties, I will try new wines. | YES/NO |
| 5. I am afraid of trying wines I have never had before. | YES/NO |

Appendix IV - Commercial wine tasting results obtained by the trained panel

Taster	Before Food				After Food				SCC*
	W1	W2	W3	W4	W1	W2	W3	W4	
1	2	3	1	4	3	4	2	2	0.4
2	3	1	4	2	1	4	2	3	-0.8
3	4	2	1	3	4	3	2	1	0.4
4	1	3	2	4	1	2	4	3	0.4
5	1	3	2	4	2	1	3	4	0.4
6	4	2	1	3	4	2	3	1	0.2
7	1	4	2	3	3	4	1	2	0.4
8	1	2	3	4	2	1	3	4	0.8
9	1	2	4	3	2	3	1	4	-0.2
10	1	3	4	2	2	3	4	1	0.8
11	3	2	4	1	2	4	3	2	0.4
12	2	3	4	1	3	2	4	1	0.8
13	1	2	3	4	1	2	4	3	0.8
14	2	1	4	3	1	3	2	4	0
15	2	3	1	4	3	1	2	4	0.4
16	1	4	3	2	1	4	2	3	0.8
17	1	4	3	2	2	1	3	4	-0.4
18	4	3	2	1	4	3	1	2	0.8
19	1	4	2	3	2	4	3	1	0.4
20	1	4	3	2	3	4	2	1	0.4
21	2	1	3	4	4	1	2	3	0.4
22	3	2	4	1	4	3	2	1	0.4
23	1	3	4	2	1	4	3	2	0.8
24	1	4	2	3	2	4	3	1	0.4
25	2	1	4	3	3	1	2	4	0.4
26	3	1	2	4	2	4	3	1	-1
27	2	4	3	1	3	4	1	2	0.4
28	4	1	2	3	4	3	2	1	0.2
Total	55	72	77	76	69	79	68	64	

*SCC – Spearman Correlation Coefficient

